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THE STATISTICIAN'S PLACE IN PUBLIC HEALTH WORK

By Edgar Sydenstricker

"What we want," said Karl Pearson, "are trained brains, and not a knowledge of facts and processes crammed into a wider range of untrained minds."

It would be difficult to find a more incisive or more comprehensive answer to the two questions recently discussed at a meeting of the American Statistical Association "What is expected of statisticians by employers?" and "How shall statisticians be trained?" than this sentence from the notable lecture in which a distinguished statistician and scientist summed up his own rich experience. The present paper in presenting the point of view of public health, medicine and biology, takes for its text this quotation because it expresses one of the fundamental requirements for all scientific work, whether the work be in research or in the application of results. It applies with peculiar insistence to the statistician; for, what is statistical method unless it is orderly reasoning by induction? So, in an unusual sense, we assert that the statistician must be a scientist. It is demanded of him not only that he shall understand the data with which he deals, not only that he be equipped with mathematical technique, but also that he shall have a trained mind, the sort of mind which old Francis Bacon described as "nimble and versatile enough to catch the resemblance of things (which is the chief point), and at the same time steady enough to fix and distinguish their subtler differences," and as possessed by a man who "hates every kind of imposture."

With this rather high standard in mind, we may consider briefly, first, certain general qualifications which should be possessed by the statistician in the field of public health, and then, more specifically some requirements for the statistician in public health administration and in the various contributory lines of research as well as in

public health research itself. Medicine, for the purposes of our discussion at least, may be regarded as synonymous with public health, since we limit ourselves in this discussion to its social and preventive aspects. It is proper also to qualify the sense in which we shall consider biology by suggesting that we are concerned here with the contributions to public health from human biology, more particularly with "that branch of biologic science," as Pearl puts it, which deals with the "quantitative aspects of vital phenomena," now recognized as biometry.

The first of two general qualifications to which attention is invited arises out of the fact that public health has a social objective. The sanitarian—by whom is meant anyone who is engaged in public health activities—of necessity must have a perspective and a responsibility that are *social*. To employ the terminology of our program, we may say that in the field of public health, and in medicine and biology as well, the "employer" is the public. Only in a very narrow administrative sense is the employer in public health personified. The sanitarian, be he laboratory technician or field investigator, visiting nurse or sanitary inspector, school physician or administrative statistician, must satisfy not merely his administrative chief, who frequently has a shorter term of office than himself, but also the local public, as well as meet the scrutiny of other workers in his own field. All of his work flows directly into the current of public activity. Just what specific training for getting this social viewpoint and for realizing this social responsibility can be afforded by the colleges and universities must be left to our pedagogical associates. The suggestion is not impertinent, however, that no one who is deliberately equipping himself for the work of a sanitarian, statistical or other, should omit adequate courses in the social sciences.

The second general qualification arises out of the fact that public health has become a profession and, I may assert, a science in itself. The various contributing sciences are being knit together, their results are being amalgamated, and a new methodology is being evolved, to constitute a body of facts and a scheme of procedure that can be learned up to a certain point more advantageously by means of formal training than by the fortunes of experience. Already a number of the large universities have begun to supply this training. The statistician in public health work cannot stand aloof as a detached worker. He should make this scholastic training in public health a part of his necessary equipment.

We come now to consider the requirements which relate more specifically to the *statistician* in public health work. Here it is neces-

sary to distinguish roughly between two rather definite fields, namely,

I. Administration, and

II. Research,

but in suggesting this distinction I do not mean to imply in any whit that the administrative statistician needs the basic qualifications less than the research worker. For the research statistician the general qualifications and training that have been emphasized are obviously essential; but without them the administrative statistician is a mere bureaucratic functionary than which I can imagine no more lamentable fate for himself or no more unfortunate thing for the public.

I. In public health administration, statistics and statistical technique are occupying more important places as the organization of record keeping is developed and as a greater dependence is placed upon accumulated experience. The functions of the statistician in this field may be outlined roughly as follows:

(1) The registration of vital statistics, which include births, deaths, marriages, cases of diseases notifiable under laws or regulations, and to which may be added the enumeration and estimation of population.

(2) The tabulation and publication of current vital data in forms suitable for biometrical and epidemiological analysis.

(3) The interpretation of vital statistics for current administrative purposes, which implies the use of proper technique for the analysis of time variables in order to distinguish between endemic conditions and the occurrence of unusual or epidemic conditions.

(4) The determination of the money cost of administrative, preventive, and control activities.

(5) To these should be added a fifth activity in which statistical procedure is fundamental, namely, the measurement of the effectiveness of preventive and control work in terms of changes in the health of the population. This is still in the research stage because few of the available methods of measurement are delicate and practical enough to afford satisfactory results. As adequate methods are devised, however, it will be expected of the administrative statistician in public health that he shall know how to employ them in order to guide the executive along lines of greatest efficiency.

To perform these duties efficiently the statistician needs a sound and broad training. Dr. W. H. Davis,[1] the Chief Statistician for vital statistics in the Bureau of the Census, has likened the public health administrative statistician to the general practitioner in medicine who must "if special problems arise which require knowledge beyond his own . . . recognize his own limitations and call upon the specialist—

[1] *American Journal of Public Health*, December, 1925, pp. 1081-1082.

whether it be a specialist in medicine, mathematics, sociology, law, epidemiology, or a specialist in some other line," but who in his own education "should not confine himself to mathematics but should acquire as broad training as possible, medical, sociological, mathematical, etc." These are undoubtedly sound statements. It appears reasonable to say that the administrative statistician in public health should include in his professional education thorough courses in certain branches of medicine and law, in public health, biology, and the social sciences, upon which should be based a training in statistical technique, particularly in administrative statistical procedure in public health. Whether he is called a sanitarian with statistical training or a statistician with a sanitarian's education does not much matter. The important thing is that he be adequately trained both in his field and in his particular functions.

II. Finally, we may consider the place of the statistician in public health research.

If there is or can be a science of public health, then here is a specialized field for workers of a high order of research ability. For as we observe the conditions that affect the physical and mental well-being of the population, as we analyze and generalize from them according to logical rules in the search for underlying laws and in the quest for formulae by which public health can be improved, and as we plan and conduct experiments in public health and interpret results, we are in fact postulating a science. In such a science the methodology is essentially statistical for the reasons that the materials are mass data and the processes are inductive. Again, many sciences contribute to public health in each of which statistical technique occupies a place of basic importance. There is epidemiology, dealing with the manifold and interrelated conditions in nature and society that influence the prevalence of disease; physiology, which is beginning to take adequate account of the variations in individuals and groups of individuals; human biology, as well as the biology of lower forms of life which are concerned in the incidence of human disease, such as parasitology and bacteriology; the study of the reactions of individuals and groups of individuals to disease, as revealed in immunology and by accumulated clinical observations and hospital records; economics and sociology, since industrial and social conditions often must be taken into account; genetics; anthropology—the list could be extended were it necessary, but it is sufficient to give emphasis to a point which I would like to offer as inherently important. It is this:

Each of these contributing sciences, as well as the science of public health itself, is a *specialty*. There is no room in any of them for dab-

blers. There is little room even for pure technicians or mechanicians, except in a subordinate capacity or as consultants in mere technique. Every worker must understand what he is doing and why he is doing it. The man or woman trained in statistical technique alone cannot walk into one of these workshops or laboratories and play with figures if he has any fear of consequences or any real sense of responsibility beyond that of an exaggerated ego; he must first understand the subject matter thoroughly and broadly, be the particular "ologist" in question, and then, if he possesses that originality and resourcefulness and humility which are indispensable to scientific work, he may apply his statistical ability to great advantage.

If this is true, where, then, does the statistician *per se* find his place in scientific research? Who, may we ask, *is* the "statistician"? I speak from the field of public health only when I say that I cannot vizualize him except as the epidemiologist, the biologist, the physicist, the chemist, the researchist in nutrition, industrial hygiene, infant welfare, *who has the statistical technique necessary for handling his facts in the mass.* The statistician in biology is essentially a biologist who knows how to generalize from, and apply the principles of experimental analysis to, biological data; in other words, he is a biometrician. And so with the other sciences, including that of public health itself. In short, since statistical method is the orderly process of inductive reasoning in any science, the *scientist must be a statistician.* To postulate less is to limit our definition of statistician on the one hand to the expert in pure statistical technique who, despite his preëminence in the field of mathematical reasoning, is a dangerous person to be let loose in fields of facts with which he is unacquainted; or, on the other hand and even more unjustly, to the mechanical assistant and statistical clerk.

On the contrary, if we are to recognize a place for the statistical method in scientific research, it would seem that our demands upon the "statistician" must be even greater and that we must require of him that, in addition to an intimate knowledge of the data in his particular field and an adequate training in statistical technique, he must understand thoroughly the principles of scientific procedure. I refer especially to those governing experimentation and experimental analysis. Unless he is so equipped, it is to be doubted that he really can apply statistical methods properly. If the essential principle of experimentation is the observation of events under controlled conditions in order to measure the influence of specific factors, it must be evident that this principle is postulated in well established statistical procedures, of which the following are only a few examples:

(1) In the preliminary elimination of such complicating factors as may be possible by *selection* of groups that are similar in all pertinent respects save that which is to be the subject of inquiry;

(2) In the establishment of "*controls*" that are essentially homogeneous with the group observed in all respects save the specific condition to be studied;

(3) In analysis by means of *manifold classification*, since in effect we are holding constant conditions a, b, c, d in order to observe and measure changes in x and y;

(4) In *partial correlation*, by holding constant certain variables believed to represent influencing factors in order to observe the association of x *and* y;

(5) In the use of the calculus of *probability* in taking into account the effect of unknown conditions that do not have a constant or correlated influence upon our series of variables.

The thing not to be lost sight of in setting up standards of training in statistics, is that methods such as these are more than mere technique. Their proper use postulates the ability to *think* scientifically. Something more than courses in technique is necessary—a *quality* of training that Professor J. A. Thompson had in mind in one of his essays where, in referring to "the pernicious fallacy, which has deceived many, that science can be pruned of its theoretical developments and yet continue to bear fruit," he pointed out that "one of the deleterious results of the fallacy is that it has suggested to students and directors of studies—at all levels—the mistaken policy of trying to secure a 'technical education' without an adequately substantial scientific training."

ON MOVING CORRELATION OF TIME SEQUENCES

By Simon Kuznets, *National Bureau of Economic Research*

I.

The coefficient of correlation as a measure of relationship between time sequences has been subjected lately to considerable criticism. It is the present concensus of opinion that the magnitude of the coefficient does not indicate the existence or absence of functional relationship between the phenomena correlated. Neither is the coefficient a satisfactory descriptive measure. For it is based on the fit of the line of regression by the method of least squares, and its size is thus unduly influenced by extreme deviations. When applied to series that are formed of deviations from the line of secular trend, it reflects too easily the misfits of the trend line.[1]

In these discussions of correlation in time series little attention is paid to the obvious fact that a coefficient fails to be a good descriptive measure for reasons less formal than its undue distortion by possible extreme variations. Even on the supposition that the correlated items, when grouped into frequency distributions, form curves in perfect conformity to the normal curve of error, the coefficient of correlation computed therefrom may be a misleading measure and of little value. The reason is that we compute it for a "given period of time."

Whenever we correlate two time series we take them for a definite historical period. But are we sure that during the thirty-five or forty years covered by the data, the degree of concurrence has remained the same? Is it not more probable that most of the factors which made for a concurrence of the two phenomena have changed materially during so long a period? And if this be true, then the coefficient of correlation computed for this period is but an average of a changing trend in covariance, an average of little descriptive and still smaller inferential value.

In economic and statistical studies which deal with correlation it is not uncommon to find an investigator computing the r between crops and prices for the period 1880–1920, and then taking the magnitude as a measure describing the concurrence between crops and prices, the latter statement without any qualifications. Such a transition

[1] "The Validity of Correlation in Time Sequences and a New Coefficient of Similarity," by O. Gresseens and E. D. Mouzon, this Journal, December, 1927, pp. 483–93.

from the coefficient for a specific period of time to a general measure of covariation of two phenomena is obviously based on the assumption that there exists a stable degree of concurrence of which the specific degree shown at each particular point of time by the pair of items is an individual, random manifestation. But such a conception of a stable and invariable degree of correlation is in disagreement with our general knowledge of the fluidity of economic relations with the passage of time.

This fluidity should prevent us from a bodily carry-over of the frequency distribution type of descriptive measures into the field of time series. We have to make sure first that there is a stable phenomenon the average value of which we want to measure. A single coefficient of correlation for a period of time is valueless, for we do not know whether there have been during this period any changes in the degree of covariance. We should modify our measurement of correlation to see whether or not there have been any secular movements in concurrence during the period. This brings us to the idea of moving correlation.

II.

It has been always the advice of careful statisticians that in computing correlation for a given period, one has to break the whole period into at least two parts, and compute two separate coefficients, thus testing the stability of the magnitude obtained. Unfortunately, for technical reasons or by sheer oversight, most of the studies in correlation do not carry through this precautionary computation. There are exceptions, amongst these the most notable being the study of D. S. Thomas, *Social Consequences of the Business Cycle.*

This method of testing the stability of the degree of concurrence may be sufficient for a negative purpose. If the periods taken are brief enough they will reveal whether or not the degree of concurrence tends to persist at the same level through the whole length of the total period covered. But the method is too crude if we are interested in seeing what particular changes took place in the relationship between two time sequences, if we desire to observe the long time changes in the degree of correlation. For this purpose we have to apply to the coefficient of correlation, as it is known at present, some principles of the moving average.

This application has been carried through by Russian statisticians, who in the rapidly changing economic conditions of their country have been forced to consider the means of taking account of varying relationships. It might be of some interest to present briefly the three types

of moving coefficient developed. In this presentation we are following the section "Changing Correlation" by S. P. Bobrov, in the Russian translation of the *Handbook of Mathematical Statistics*, edited by H. L. Rietz, Cambridge, Massachusetts. The translation and adaptation for the Soviet reader has been done by S. P. Bobrov.

The simplest coefficient, that of Professor B. S. Yastremski, calls for cumulating the sum of the xy products. If the sigmas of the two correlated series do not change appreciably during the period studied, then the movement of the cumulative sum of the xy products shows the trend in the degree of concurrence. If the sum rises or falls along a straight line, the degree of correlation is stable through the period. If it shows a parabolic movement, then the degree of concurrence is becoming higher or lower according as the curve is concave or convex. If the line changes direction, the relationship declines.

Professor Yastremski's coefficient has the advantage of simplicity, but it assumes the stability of the standard deviation, which in time series covering a considerable period of time is the exception rather than the rule. For this reason the more complex methods are preferable.

The *sliding* coefficient of S. P. Bobrov is really a coefficient of correlation that changes like a moving average. It calls for choosing an interval, which in annual data might, for example, be twenty-five years. For the first twenty-five years of the period we compute then the sum of the xy products, and the sum of the square deviations for each of the series. The division of the sum of xy by the product of square root of the Σx^2 and of the Σy^2 will give us the r for the first twenty-five years. We take then the xy, the x^2, and the y^2 for the twenty-sixth year and omit the same items for the first year. We thus obtain the r for the next twenty-five-year period, removed by one year from the first period. By thus moving all the three components of the formula, we obtain a moving coefficient of correlation with a value for each year. We may center it then at the midpoint of the interval.

A third method of measuring secular changes in the degree of concurrence was offered by N. S. Tsechetwerikov. It calls for plotting the lines of the three components of the formula, of the successive xy products, the x squares, and the y squares. To these three lines smooth curves are fitted by the method of least squares. It is preferable not to go beyond parabolae of the second or of the third order. The *secular* coefficient of correlation may then be computed for every point of time from the three components taken off the fitted curves. It is quite possible that for single points it may be larger than 1 or less than -1.

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Of the two methods just described, that of Bobrov seems preferable. It does not introduce any changes into the mathematics or logic of the Pearsonian r and is the least cumbersome of the two methods. In our attempts to see whether time series exhibit any stable correlation through considerable periods we have used this method. The results of its application to widely used time series are quite surprising.

III.

The data to which the moving coefficient of correlation was applied were all taken from our study of *Secular Movements in Production and Prices*,[1] carried through during 1925–27 under the auspices of the Social Science Research Council. In this investigation the main interest was in finding out the nature of secular movements. The latter were described by two approximations. First, a three constants curve was fitted to the data. For the price series it usually was a second degree parabola fitted by the method of least squares, for the production series a simple Logistic or Gompertz curve fitted to points selected from moving averages of the original data. The elimination of this curve, which we called the line of primary trend and considered the first approximate description of secular movements, usually revealed the presence of an additional group of secular changes, the secondary ones. A moving average was fitted to the deviations from the line of primary trend, and the average smoothed so that it passed approximately through the center of each observable cycle. The deviations from this smoothed moving average we called then the items of cyclical fluctuations, and it is these deviations which are correlated in the examples below. Be it also mentioned, that all the series were annual, and for periods on the average of about sixty years duration.

The brief description of this analytic procedure shows that there is little danger of an ill-fitting trend line affecting the results of correlating the deviations. For the lines of primary trend were not chosen unless they presented a good description of the movements as they were seen throughout the whole period covered by the series. And the application of the smoothed moving average to the deviations from the line of primary trend took care of all the remaining secular movements that displayed themselves through a period longer than that of the average cycle. While undoubtedly an unavoidable residue of the secular element is still present in the deviations from this moving average, we can accept the series of these items as a sufficiently "pure" description of the cyclical oscillations observable in the series.[2]

[1] Unpublished manuscript.

[2] In order not to overburden the article we are not quoting the series themselves.

In applying Bobrov's sliding coefficient to these data, there first had to be answered the question as to the length of the interval. For annual data this question is particularly difficult. On the one hand, we do not want to make the period too long, for fear that it might cover periods through which the economic conditions determining covariance changed considerably. On the other hand, we need a considerable number of items, a number sufficient to prevent any vigorous accidental disturbances that might obscure the underlying secular movement in the degree of correlation. The difficulty is obviously of the kind that does not allow for solution by any set up criterion, but requires an experimental procedure of trial and error.

After experimenting with intervals of 19, 25, and 31 years, we decided that the 25-year interval would be the best. This, possibly, means erring on the side of taking a group of too few items. But it was considered important to have an index that would be sensitive enough to reflect the secular movements in the relationship between series. The 19-year interval shows too violent year-to-year changes, while the 31-year period reduces the possible range of observation quite considerably. In all the examples cited we are therefore using the 25-year interval.

Table I presents moving correlation of crops and prices for three important crops in the United States. The prices are December farm prices, and the crops as estimated by the United States Department of Agriculture.

TABLE I

MOVING CORRELATION OF CROPS AND FARM PRICES, WHEAT, CORN, AND POTATOES, UNITED STATES, 1866–1915

Simultaneous items. Interval of 25 years

Midyear of interval	Value of the coefficient			Midyear of interval	Value of the coefficient		
	Wheat	Corn	Potatoes		Wheat	Corn	Potatoes
1878	−.607	−.708	−.892	1891	−.244	−.850	−.901
1879	−.379	−.676	−.896	1892	−.333	−.868	−.899
1880	−.408	−.662	−.899	1893	−.337	−.873	−.900
1881	−.343	−.659	−.901	1894	−.284	−.865	−.888
1882	−.234	−.674	−.896	1895	−.279	−.878	−.889
1883	−.242	−.760	−.914	1896	−.277	−.875	−.892
1884	−.238	−.781	−.917	1897	−.203	−.874	−.886
1885	−.224	−.775	−.918	1898	−.181	−.874	−.868
1886	−.261	−.783	−.903	1899	−.172	−.879	−.898
1887	−.228	−.749	−.907	1900	−.164	−.877	−.890
1888	−.208	−.745	−.895	1901	−.145	−.882	−.889
1889	−.244	−.817	−.898	1902	−.120	−.879	−.902
1890	−.244	−.830	−.898	1903	−.070	−.872	−.897

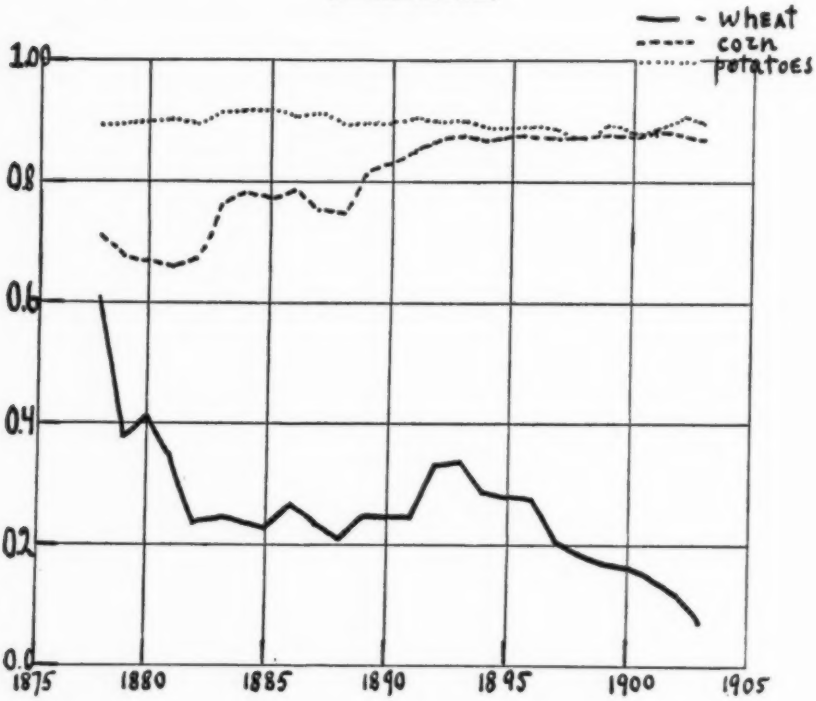
It is to be seen that the coefficient of correlation between wheat crops and prices dropped from about −.6 for the quarter century centering about the late '70s to about −.2 or −.1 for the twenty-five

years about the end of the '90s. It is interesting to notice that for the whole fifty years covered the coefficient is $-.35$. It is quite a small coefficient, and the probable error of the r is .12. But as it stands, it certainly gives a misleading impression of the degree of concurrence between the two series. The vigorous secular change in the coefficients goes to show how dangerous it is to rely on a single coefficient of correlation even as a measure describing the existing degree of concurrence. Its inferential value, under changing conditions as described in the chart, is quite hard to visualize.

CHART I

MOVING CORRELATION OF CROPS AND PRICES, UNITED STATES

(Simultaneous Items)



In the case of corn we have obviously a secular change in a direction opposite to that of wheat. While during the twenty-five years centering around the late '70s the coefficient was slightly below $-.7$, it rose to about $-.87$ in the early '90s and has remained on these levels to the end of the period. In the correlation of potato crops and prices we have the only case (out of some twenty-five to thirty investigated) where the coefficient has remained quite stable throughout the period.

It is only under such exceptional conditions that the coefficient for the whole period or for any considerable part of it has a high descriptive value, and therefore can be used in economic reasoning as an element in establishing sequences. The coefficients for the whole period are $-.782$ for corn, and $-.89$ for potatoes. The measure for corn crops and prices misrepresents the situation, for it undervalues the degree of concurrence for the last forty years.

We have been taking so far simultaneous items, and thus dealing with the same material and the same methods which are used by the quantitative and mathematical economists in computing the equations of demand. It is obvious that the mobility of the coefficient of correlation affects their computations and inferences just as much as of those who would interpret its magnitude as only a descriptive measure, and stop at that. Clearly, one cannot take the pairings of crop-price deviations as single items of an unchangeable demand curve. This latter changes through time, as is shown by the movements in the coefficient of correlation which is its determining component.

In this connection it is interesting to correlate prices for a given year and crops for the year following, in order to see what happens to the coefficients of correlation which are frequently used to determine the supply curve. In Table II we have the moving correlation of crops and prices, crops lagging one year, for the same three pairs in the United States.

TABLE II

MOVING CORRELATION OF CROPS AND FARM PRICES, WHEAT, CORN, AND POTATOES, UNITED STATES, 1866–1915

Crops lag one year. Interval of 25 years

Midyear of interval	Value of the coefficient			Midyear of interval	Value of the coefficient		
	Wheat	Corn	Potatoes		Wheat	Corn	Potatoes
1878	.339	.273	.384	1891	.568	.194	.328
1879	.362	.264	.413	1892	.564	.212	.345
1880	.358	.259	.389	1893	.545	.183	.353
1881	.423	.264	.365	1894	.508	.210	.410
1882	.434	.271	.382	1895	.517	.227	.401
1883	.448	.165	.302	1896	.522	.209	.440
1884	.465	.157	.339	1897	.463	.238	.443
1885	.533	.124	.327	1898	.447	.241	.432
1886	.533	.138	.344	1899	.462	.261	.478
1887	.543	.087	.331	1900	.457	.253	.471
1888	.485	.096	.328	1901	.428	.266	.504
1889	.468	.120	.339	1902	.418	.208	.468
1890	.478	.118	.326				

Of the three series, only wheat and potatoes exhibit any significant degree of covariance. In both it is positive now. In wheat there is an unmistakable rise from about .34 in the twenty years centering about

the late '70s to about .50–.55 during the period covering 1873–1908, declining to the end. A similar movement, but coming much later and manifesting less vigor, is to be observed in the potato crops and prices. The rise there starts from the twenty-five years centering about 1893.

The total coefficient for wheat is .364, a case of obvious misrepresentation. As in the preceding case for wheat crops and prices it is due to the change in the average magnitude of correlated items, those in the early part of the period being much higher than those in the later. This is also the reason for the non-representative character of the total coefficient for corn (mentioned above). The coefficient for the whole period in case of potatoes is .379, a much more representative average. This is due to the fact that the average size of the correlated items has not changed appreciably throughout the period.

The movements shown above in the degree of covariance between crops and prices suggest interesting speculations as to their causes. Is the decline in the closeness of connection between wheat crops and prices of the same year to be explained by the declining rôle of American wheat in the international market, the prices being determined internationally? Is the rise in the positive correlation between crops of this year with prices of preceding years due to the cessation of territorial expansion, to the increase in the means of information and communication, to the greater penetration of the business spirit into farming? These reasons all seem fairly obvious, and help to suggest the wealth of historical information that would lead one to conclude that stable correlation must be the exception rather than the rule. But a detailed discussion of the dynamic economic factors is outside the scope of this article.

IV.

To use annual data in the study of output and prices of minerals and of manufactured goods is much less legitimate than to do so for crops, for the former processes are elastic, and may be changed from month to month in response to monthly changes in prices and in other market conditions. Still we are interested mainly in the secular changes in the coefficient of correlation, and while those are only roughly pictured with the help of annual data, we still might use the available series to obtain approximate results. A graphic inspection of the series preceded the computation of the coefficients and, where necessary, lags were allowed for. The changes in the coefficient cited below can hardly be ascribed to changes in time sequence between the oscillations.

In Table III we have moving correlation indices for output and prices of three commodities: bituminous coal, pig iron, and crude petroleum. The prices are given for a definite month in the year, and while each item is thus affected by the seasonal element, the changes are not. Besides, the seasonal in price of non-agricultural commodities is insignificant, and any possible changes in the seasonal could hardly affect greatly the validity of the comparison.

TABLE III

MOVING CORRELATION OF OUTPUT AND PRICES, BITUMINOUS COAL, PIG IRON, AND CRUDE PETROLEUM, UNITED STATES

Simultaneous items except for petroleum II

Petroleum II—Output lags one year. Interval of 25 years

Midyear of interval	Value of the coefficient				Midyear of interval	Value of the coefficient			
	Bit. coal	Pig iron	Petroleum I	Petroleum II		Bit. coal	Pig iron	Petroleum I	Petroleum II
1866	....	.759	.....	....	1885	.487	.796	−.331	.245
1867	....	.779	.....	....	1886	.385	.695	−.251	.341
1868	....	.788	.....	....	1887	.419	.712	−.208	.268
1869	.322	.815	.....	....	1888	.421	.676	−.272	.196
1870	.354	.819	.....	....	1889	.377	.629	−.208	.225
1871	.439	.815	.....	....	1890	.324	.500	−.178	.252
1872	.362	.818	.....	....	1891	.264	.533	−.175	.247
1873	.371	.831	.....	....	1892	.267	.574	−.170	.303
1874	.359	.826	−.587	.018	1893	.379	.484	−.179	.384
1875	.382	.822	−.511	.048	1894	.376	.486	−.120	.539
1876	.376	.824	−.506	.060	1895	.322	.511	−.027	.535
1877	.409	.812	−.433	.212	1896	.224	.487	−.014	.533
1878	.415	.819	−.337	.257	1897	.393	.463	−.015	.552
1879	.431	.820	−.351	.231	1898	.371	.406	.006	.524
1880	.430	.813	−.461	.200	1899	.346	.424	.008	.529
1881	.446	.807	−.424	.215	1900	.347	.420	.018	.526
1882	.445	.810	−.409	.207	1901	.360	.427	.006	.511
1883	.445	.809	−.386	.229	1902	.329	.367	.009	.472
1884	.492	.811	−.358	.246	1903	.335	.347	−.076	....

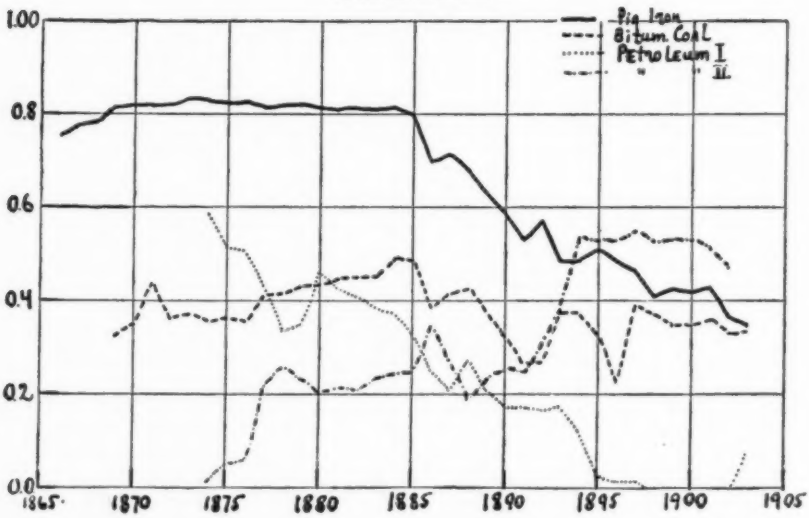
The lines for pig iron and bituminous coal show similar movements, at least in the later half of the period. The coefficient for pig iron, after remaining on a stable level of about .8 up to the period centering at 1885 declines markedly and reaches a value of about .35 for the period centering at 1903. The same decline, but in a much less marked form, is observed in bituminous coal, where the coefficient falls from about .45 to about .35. An inspection of the series shows that the high coefficients during the '70s and '80s are due to the presence of vigorous and well correlated cyclical oscillations during the '70s and the early '80s. A similar feature is observed in other series and in other countries.

The case of petroleum is of particular interest, presenting a movement of correlation not unsimilar to that of wheat. If we correlate output and prices for the same year, the value is negative, and it

declines quite vigorously in size all through the period. It falls from about .55 in the early part to something about .0 at the end. But if we correlate the prices of a given year with the output for the following year (thus computing the elements of the supply curve) we obtain positive correlation growing in size all through the period, from .0 to about .5. These conspicuous movements of the coefficient obviously reflect some fundamental changes in the character of the industry and of its market, a change possibly from the early periods of abundant new wells with somewhat chaotic and feverish production, to the later forms of a more heavily equipped, more solidly organized industry.

CHART II

MOVING CORRELATION OF OUTPUT AND PRICES, THREE COMMODITIES, UNITED STATES



It is interesting to notice that the correlation of anthracite coal shipments and prices (simultaneous items) shows also a decline from about $-.35$ during the period centering about 1858–89 to about .0 for the twenty-five years around 1891–1903.

The coefficients for the whole period are: 0.6 for pig iron, 0.33 for bituminous coal, $-.35$ for petroleum I, and $+0.2$ for petroleum II. Of these, the coefficients for pig iron and bituminous coal represent fairly well the central tendency, but none of the four, of course, gives an inkling of the vigorous movements in the degree of concurrence which are shown on our chart.

We have investigated other United States series of output and of prices, in an analogous fashion, but their recital would overburden

this article. The series investigated so far include portland cement, copper, lead, zinc, steel. None of them shows stability of the coefficient, such as that shown in the case of potatoes.

Table IV shows the moving correlation of pig iron output and prices in four countries, other than the United States. It covers approximately the same period and thus enables us to judge as to what extent the mobility of the coefficient of correlation is a generally observed phenomenon, and whether or not the movements noted are shared by all the countries.

TABLE IV

MOVING CORRELATION OF PIG IRON OUTPUT AND PRICES, GREAT BRITAIN, BELGIUM, GERMANY[1] AND FRANCE

Simultaneous items except for Great Britain and Belgium, where prices lag one year. Interval of 25 years

Midyear[2] of interval	Value of the coefficient				Midyear of interval	Value of the coefficient			
	Great Britain	Belgium	Germany	France		Great Britain	Belgium	Germany	France
1862.....	....	.711	....	.595	1882....	.566	.355	.897	.687
1863.....	....	.675	....	.557	1883....	.577	.372	.903	.691
1864.....	....	.603	....	.514	1884....	.490	.302	.902	.749
1865.....	....	.640	....	.494	1885....	.365	.106	.879	.725
1866.....	.689	.625	....	.502	1886....	.340	.084	.777	.754
1867.....	.606	.428	....	.511	1887....	.400	.101	.792	.748
1868.....	.617	.386	....	.474	1888....	.387	.095	.802	.722
1869.....	.603	.340	....	.442	1889....	.406	.156	.757	.688
1870.....	.581	.349	....	.470	1890....	.406	.125	.750	.680
1871.....	.536	.340	....	.489	1891....	.381	.144	.730	.665
1872.....	.534	.321	.914	.484	1892....	.482	.255	.725	.639
1873.....	.534	.318	.898	.498	1893....	.494	.275	.745	.634
1874.....	.523	.326	.905	.552	1894....	.497	.323	.720	.623
1875.....	.522	.320	.909	.579	1895....	.485	.314	.699	.594
1876.....	.523	.320	.915	.589	1896....	.576	.353	.688	.578
1877.....	.563	.344	.916	.593	1897....	.586	.346	.710	.555
1878.....	.560	.338	.905	.581	1898....	.533	.279	.724	.532
1879.....	.606	.355	.907	.599	1899....	.520	.240	....	.399
1880.....	.557	.353	.905	.607	1900....	.454	.254	....	....
1881.....	.547	.356	.903	.618					

[1] Consumption of pig iron.
[2] Years indicate intervals in the output series.

The movements of the coefficients are considerable in all the cases. Germany shows a decline similar to that in the United States, the breaking point in both being about 1885. The lines for England and Belgium move well together. They both decline to about 1885, and show a rise thereafter. For France we observe a rise to 1885, but after that date there is a decline similar to that in the United States and Germany. The '70s in all the series are marked by a high amplitude of well correlated cyclical fluctuations.

The coefficients for the whole period are: 0.50 for Great Britain, 0.39 for Belgium, 0.84 for Germany, and 0.58 for France.

Inspection of Table IV suggests that high correlation of time

sequences is probably a matter of individual historical occurrence, limited to single historical epochs, and thus should always be conceived as a passing phase, rather than as a stable static situation. If one may surmise on the basis of a limited sample one is led to conclude that high correlation is likely to result wherever there are considerable cyclical fluctuations. Where the up and down movements are considerable, we can reasonably expect that the oscillations in production and prices will be in good correspondence. Where, on the other hand, we have only mild price changes we might very well have for a time production and prices moving in opposite directions. But since most of the series show a tendency towards a change in the amplitude of fluctuations, we might expect in most of the cases a change in the value of the coefficient.

We have been correlating so far only production and prices. It might be interesting to see the correlation of cycles in one branch of production as compared with another, or the same branch of productive activity in different countries. An example of such a comparison is shown in Table V.

TABLE V

MOVING CORRELATION OF PIG IRON CONSUMPTION, GERMANY

A. Pig iron consumption, Germany, and pig iron output, Great Britain
B. Pig iron consumption and coal output, Germany

Simultaneous items. Interval of 25 years

Midyear of interval	Value of the coefficient		Midyear of interval	Value of the coefficient		Midyear of interval	Value of the coefficient	
	A	B		A	B		A	B
1872	.582	.669	1882	.584	.778	1892	.703	.648
1873	.571	.664	1883	.637	.774	1893	.725	.643
1874	.581	.666	1884	.659	.777	1894	.782	.653
1875	.585	.663	1885	.624	.788	1895	.762	.666
1876	.582	.673	1886	.712	.798	1896	.763	.611
1877	.594	.682	1887	.745	.790	1897	.753	.582
1878	.593	.748	1888	.736	.806	1898	.785	.560
1879	.597	.732	1889	.762	.749	1899	.766	.536
1880	.578	.745	1890	.768	.734	1900	.675	.564
1881	.578	.779	1891	.754	.695	1901	.688	.633

Table V shows that the degree of concurrence between two industrially related branches of productive activity in Germany, pig iron and coal, has undergone changes similar to those in the concurrence between pig iron price and consumption. Thus it declines from .7 during the twenty-five years centering about 1885 to about .5 near the end of the period. But, as ought to have been expected, the correlation between English and German pig iron activity has, if anything, grown closer. From about .58 in the beginning of the period it has risen to about .65 at the end. It might be surmised that it is in-

dicative of the growing ties of international economic relations. But whether or not it is a general phenomenon can be found out only if a larger number of cases is investigated.

That it is not so in at least one international comparison of prices can be gathered from Table VI. Here we have pig iron prices com-

TABLE VI

MOVING CORRELATION, PRICE OF PIG IRON, GREAT BRITAIN

A. Pig iron price, Great Britain and United States
B. Pig iron price and coal price, Great Britain

Simultaneous items. Interval of 25 years

Midyear of interval	Value of the coefficient		Midyear of interval	Value of the coefficient		Midyear of interval	Value of the coefficient	
	A	B		A	B		A	B
1866	.725	.864	1878	.712	.897	1890	.594	.690
1867	.702	.888	1879	.710	.885	1891	.519	.680
1868	.700	.882	1880	.709	.882	1892	.546	.671
1869	.714	.899	1881	.691	.894	1893	.549	.691
1870	.719	.905	1882	.694	.898	1894	.565	.671
1871	.733	.907	1883	.669	.897	1895	.554	.678
1872	.736	.899	1884	.668	.904	1896	.558	.669
1873	.742	.894	1885	.596	.909	1897	.549	.685
1874	.743	.897	1886	.537	.828	1898	.531	.700
1875	.724	.903	1887	.649	.765	1899	.528	.708
1876	.720	.901	1888	.696	.793	1900	.524	.707
1877	.707	.901	1889	.692	.724	1901	.563	.674

pared in two countries, as well as with a price of coal in the same country. Both of these, just as the price-output correlation, show a decline in the degree of concurrence, the movements of the lines being surprisingly similar. The reliable differences in behavior between the various groups of moving coefficients can, however, be established only after a time-taking examination of all the other series of any significance.

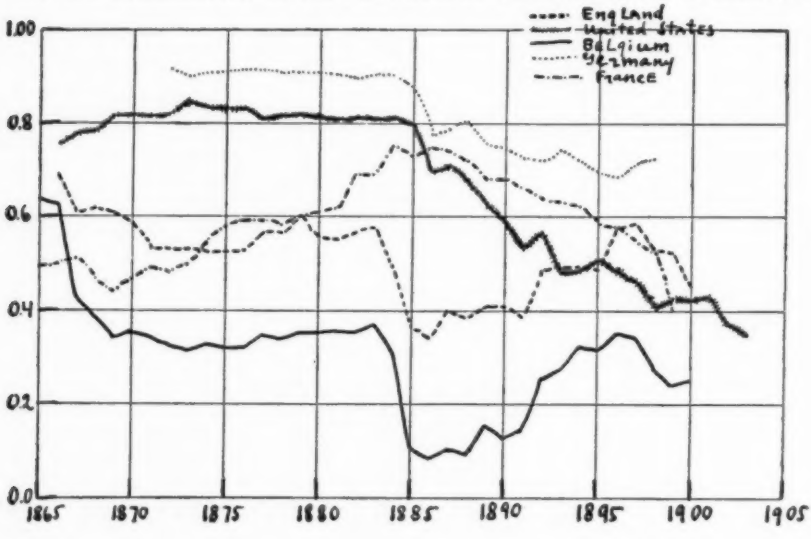
Before we summarize the showing of the cases cited, we might attempt to ascertain as to what extent the results shown depend upon the annual character of the data used. One of the limitations imposed by it is the taking of a small number of cases in the computation of the coefficient. For we are compelled to take a limited period of time in order not to confuse heterogeneous conditions. In monthly data the number of single items would be appreciably larger, and thus the shift of one item would not mean as much change as in any of the examples cited above.

But the small number of cases in the interval, while making for a limited significance of each particular change, can hardly invalidate a showing where we have a fairly continuous rise or decline through more than one decade. In such a case we might reasonably expect that the monthly data for the same period would show a similar movement.

Another misleading effect of the annual data may be in the different character of the cycles that are observed, different from the cycles observable in monthly data. We may have a case, as can be seen in pig iron output, United States, during 1885–94, where one long cycle observed in the annual data resolves itself into three cycles on a monthly scale. These three cycles, it is true, are superimposed upon that long cycle observed in the annual index, and the latter shows notches in correspondence with the shorter monthly data. But it is quite possible that with the passage of time, these long cycles disappear and there is

CHART III

MOVING CORRELATION OF PIG IRON OUTPUT AND PRICES, FIVE COUNTRIES



a greater correlation of monthly and annual data. While this may happen in one of the time sequences, it may not happen in the other. As a result correlation between annual data would show a change, while correlation for the same period between monthly data would show no change at all.[1]

Such a contingency would alter the significance of the movements in the coefficient between annual data, but would hardly invalidate the importance of such changes. It should prevent us from assuming that the trends in correlation of annual data would be the same as in monthly data, and point to the importance of testing the correlation of monthly series in a similar way.

[1] I am indebted to Dr. A. Achinstein who showed me the correlation charts for monthly output and prices of pig iron in the United States.

But for this exception occasioned by a considerable change in the duration of cycles, the annual data should give an approximate picture of the changes in the covariance of two phenomena. True, the annual items are but rough averages, but the general direction of the change should be reflected well by it. It is thus fair to assume that the illustrations provided above should cast a healthy doubt upon the stability of the coefficients of correlation computed for monthly data.

In summarizing now the results of the few experiments, some of which were cited above, we may say that:

1. Most of the time sequences, in terms of the annual data, show significant movements in the degree of concurrence. Of the twenty-five to thirty pairs of series examined only one showed a stable coefficient.

2. Our knowledge of economic events and of their extreme changeability suggests to us that it is most probable that the coefficients of correlation, which are but summary measures of correspondence, should be variable and their stability an exception. For where all the factors that determine correspondence change, it is improbable that their changes will not affect the degree of concurrence.

3. A number of the coefficients for the whole period misrepresent the central level of correlation as shown by the moving coefficient. This is due to the change in the size of the items correlated.

The extremely tentative character of these findings is too obvious to need mentioning. The purpose of the article is not so much to establish positive generalizations, as to raise a question as to the significance of a widely used statistical measure. And in order to make this question more forceful, we might end the article with a brief recital of some implications of the tentative findings cited:

A. It is obvious that in an attempt to arrive at a measure of correlation which would be a reliable description, we have to establish the homogeneity of the epoch described. This may be done in various ways. The most obvious empirical way is to limit the period for which correlation is computed, and then test its stability by shifting the period. It is possible that lines of moving correlation will be found an unavoidable if cumbersome measure of describing correlation between time sequences.

B. This affects immediately all the uses of the coefficient of correlation, except possibly those where it is used to determine the lag. It is particularly important for its uses in the construction of the supply and demand curves. The formulae for the latter should be changed correspondingly, for it might be impossible to speak of the

average response of production to price or vice versa, except in terms of a moving average.

C. Thus, before statistical analysis of time series can be used as a statistical complement of static economic theory, extreme care should be taken to eliminate all the historical or dynamic elements from the analyzed time sequence. The elimination of trend does not eliminate the effects of the change in trend on the deviations from it. And a straight correlation of series does not eliminate the historical change of factors that determine covariance. The empirical element with which quantitative theory has to deal is more historical than it would seem at first glance. And there is a corresponding need for a material change of the somewhat too static methods of a biometric frequency statistical mechanism.

LONG-TIME GUARANTEES OF PROSPERITY

By Robert M. Davis, *McGraw-Hill Publishing Company*

Statistics on basic economic subjects have come into their own only during the past half decade, and with this gradual acknowledgment of the importance of the subject have developed the functions of the statistician. In the memory of many members of the American Statistical Association, the statistician was merely a high-class clerk, making surveys and tabulating results. But this rather disparaged "figure hound" has gradually evolved, grown with the importance of statistics, until today he is recognized as a man who can pierce the future with considerable accuracy, and whose thoughts based upon his statistical research are worthy of serious consideration. The statistician of today must be very much of an economist, banker, agriculturist, miner, wage earner and engineer. He must not only gather the basic data upon economic operations, but he must interpret these data, not based upon certain theories which he may find in textbooks, but upon his intimate knowledge of the fields upon which these data bear. From a high-class clerk on clerk's wages, he has climbed to the position of an expert with the wages of an executive within his grasp. Today individual statisticians are confining their interest largely to one phase of America's economic life, and through their intimate knowledge of special fields are able to interpret the results of their field surveys not only in the language of the field concerned, but in an authoritative manner.

It is but natural, therefore, that the statistician should turn his thoughts to the causes for our long continued period of industrial prosperity. His figures indicate the gradual displacement of manpower in industry, and the consequent greatly increased production per worker. His market studies indicate the modernization of the technique of distribution through field studies of the buying habits of the American public and American industry. Through the gathering of the basic data there passes before his eyes information on the gradually increasing purchasing power of the public and the natural trait of that public to accept and use new products once they have proven their worth. As a result, he has gradually developed a composite picture of industrial changes based entirely upon his statistical research work.

The statistician finds that there are two economic developments which determine the relative business and industrial conditions of our nation. First are those developments which are like the waves on the

seashore—advancing and receding, more or less temporary in character —and secondly, are those developments which are like the mighty tides of the ocean, steadily rising and advancing, overwhelming in their influence on general national conditions—well termed by Mr. Edward J. Mehren, Vice-President of the McGraw-Hill Publishing Company as "our long-time guarantees of prosperity."

In addition to the more or less changing economic factors concerning which we read so much in newspapers and economic reports, there have developed in this nation mainly since the war period basic factors of a long-time nature which can truly be termed largely American in character. These are the influences which strongly presage a continuance of our general prosperous conditions for some time to come.

There has developed during the past half decade a most interesting and significant industrial balance. It wasn't so very long ago that we believed most implicitly in the slogan "as goes the iron and steel industry, so goes the nation." If pig-iron and steel-ingot production were on the downward trend all eyes were focused upon the horizon, ready to dash for the storm cellar at the first appearance of the expected industrial cyclone. To a large extent this belief still prevails, but the products of other primary industries have become during the past few years so interwoven into the very social fabric that the operations of these other industries now exert a large influence on the general industrial situation. The very favorable economic condition resulting from this new set-up of industrial influence was well brought out during the fall months of last year.

In August we find that data on electrical energy consumption by manufacturing plants indicate that seven of the nation's primary industrial groups were operating at a rate considerably below that reported for August, 1926. The rolling mills and steel plants recorded activity about 2 per cent under August, 1926, and the activities of the ferrous and non-ferrous metal working plants were about 7 per cent under 1926. On the other hand, three just as basic industrial groups—lumber, textiles and rubber—reported activities during August materially over August, 1926. As a result, when these industrial groups are weighted in accordance with their importance in the general industrial structure, we find that the rate of production in industry as a whole during August was only 0.3 per cent under that witnessed during August, 1926, instead of around 5 per cent under 1926 as would be indicated by the operations of the iron and steel and metal industries.

Again in September we find this industrial balance still maintained. The rolling mills and steel plants had materially decreased their activities to a point 9 per cent under 1926, and the metal working plants had

decreased their operations to a point 11 per cent under 1926. Operations in the automobile manufacturing plants were 15 per cent under September, 1926. On the other hand, the food industry had materially increased its operations to a point 13 per cent over 1926, and the lumber and lumber products industry was operating at a rate 20 per cent over the year previous. As a result, when we weight these various industries in accordance with their influence, we find that the rate of general industrial operations during September was only about two-tenths of one per cent under 1926 instead of 10 per cent under 1926 as would be indicated by the operations of the iron and steel industry.

In October we find the various industrial groups operating at rates closer to 1926, some above, some below, but still maintaining a balance in general industrial operations. And similar conditions were true in November and December.

These conditions make clear that the overwhelming influence of the iron and steel industrial operations has been largely dissipated by the rising influence of these other industrial groups. Now, what has been the cause of this new alignment of American industry? The underlying reasons are five-fold: First, increased use of power per worker; second, the receptibility of the public to new commodities; third, modernized distribution technique; fourth, increased purchasing power of the public; and fifth, industrial research.

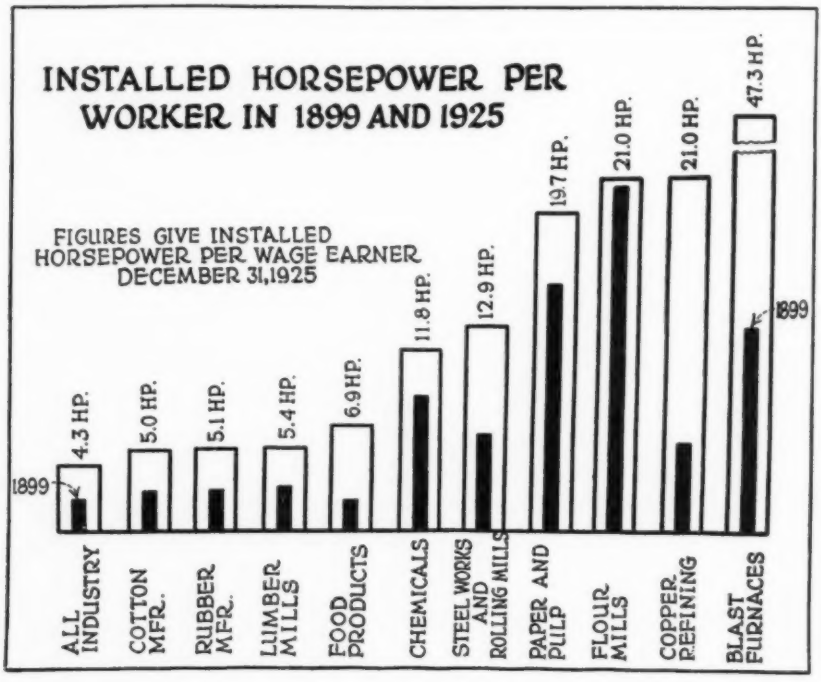
During the past 28 years a very significant change has taken place in the economics of American industrial production. We have transferred the work of industry from the backs of men to the inanimate forces of steam and electricity. At the present time blast furnaces have installed 47.3 horsepower per worker, an increase in the use of mechanical power per worker of 273 per cent since 1899. The food industry now has 6.9 horsepower installed per laborer, an increase of 263 per cent since the opening of the century. Industry as a whole now has 4.3 horsepower installed per wage earner, or just double the mechanical power installed per worker in 1899.

As a result of this greatly increased use of power and machinery, 67 men now do as much work as 100 men did before, and in some industries this surplus of labor has been very much higher per 100 men employed.

Now we know that we have not had an ever increasing army of unemployed. Where then has this surplus labor gone? It has gone in two directions. A large proportion has entered non-manufacturing industries. Today it is estimated we have 150,000 more automobile service men than in 1920, 100,000 more insurance agents, 100,000 more in construction management, 250,000 more teachers, 125,000 more movie operators, 170,000 more barbers, 525,000

more hotel and restaurant employees, and—as some have suggested —100,000 more bootleggers. A second proportion has gone into new industries and is making products undreamed of in 1899. Products which are recognized as absolutely essential to our modern social life—automobiles, radios, vacuum cleaners, talking machines, refrigerators, washing machines, rayon and the other products of the chemical laboratory—were unknown to most of our parents when they

CHART I



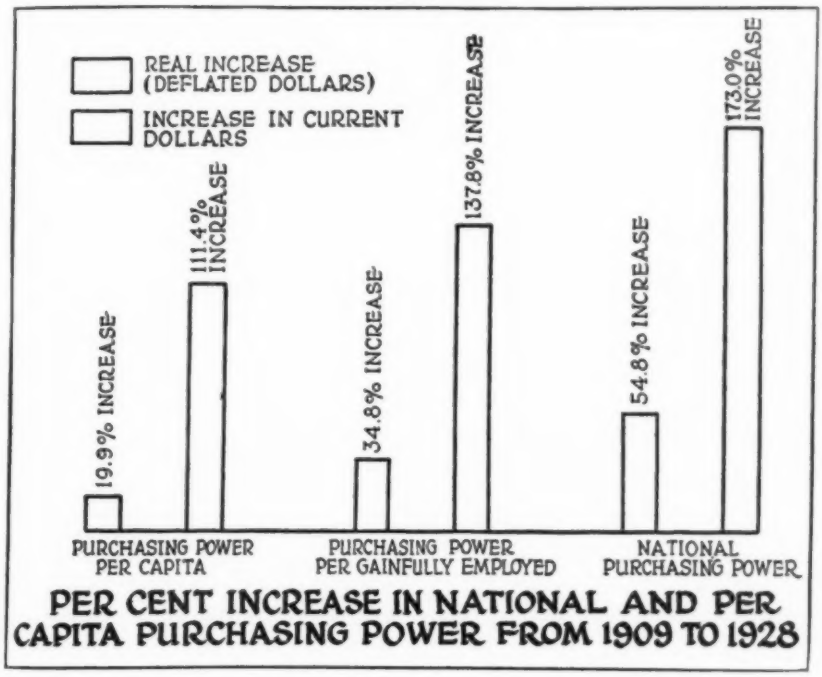
began their home life. And yet there is every reason to believe that we are but at the beginning of new developments and new discoveries. It is in the manufacture of this ever growing list of new commodities that America has absorbed a large portion of her surplus labor.

At the bottom of this development of new products lies a peculiarly American trait—that of the people to accept and use new products once they have proven their worth. The European trait of "following in the footsteps of the fathers" has given way to the American trait of "just as far away from the footsteps of father as possible." As a result these new industries have grown to huge proportions, and through the increased use of power and machinery these new industries

have in turn thrown off surplus labor to be absorbed in other new industries.

The very significant result of this ever increasing use of power per worker has been a materially increased production per worker. While the number of workers in manufacturing industry has been growing less and less, the volume of products manufactured has been growing greater and greater. During the past five years the production per worker in industry as a whole has increased by about 20 per cent.

CHART II



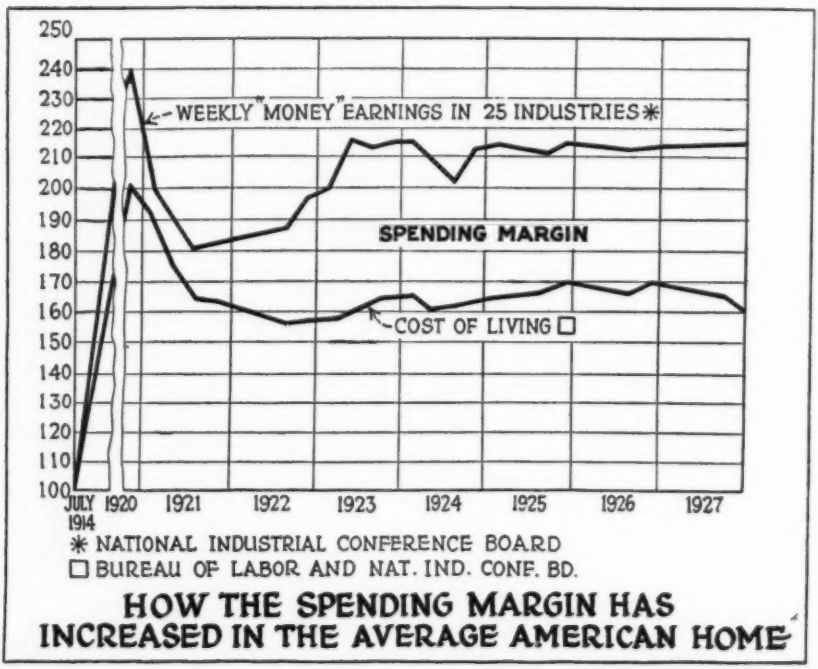
Not only have great strides been made in the economics of production but the technique of distribution has been entirely modernized. This has been accomplished through a careful study of the buying habits of the public and of general industry, through the elimination of waste—both material and physical—and through rapid and cheapened transportation. Distribution and merchandising today is an art, as much a science as is the study of engineering.

These tendencies in production and distribution, taken in connection with the distribution of technical knowledge through the technical press as well as the non-technical press, have educated the American

public to a commodity demand which is without parallel in any other nation on the face of the earth. Our social psychology of today is entirely different from that of pre-war times.

As a result of these economic conditions we find that there has been an ever increasing spread between the wages received by American labor and the cost of living, leaving a greater and greater margin avail-

CHART III



HOW THE SPENDING MARGIN HAS INCREASED IN THE AVERAGE AMERICAN HOME

able for recreation, saving, insurance, and the purchase of manufactured products. At the opening of the year the statement was made that the limit of this spread between income and the cost of living had been reached, but 1927 appears to have increased the margin even further. And yet I would not have you think that our present income, especially among that 65 per cent of our population classed as the "poorest group," is such as to warrant their experiencing too much prosperity, or that they are getting more wages than they know how to spend. Professor Irving Fisher of Yale recently brought out "that the present average annual family income of 80 per cent of our population is only $117 more than that necessary to provide the minimum of health and decency, below which a family cannot go without danger of physical and moral deterioration."

But it is certain that the purchasing power of the American public has materially increased in the last 20 years. The present purchasing power of the nation as a whole in deflated dollars or real purchasing power is 55 per cent over that of 1909, and in current dollars is 107 per cent over 1909. The increase in real purchasing power per capita is 20 per cent over 1909, and that of the gainfully employed is 35 per cent over 1909.

Here then is one answer to this present ability of industry to maintain an average high rate of production while some of the most basic industries such as that of iron and steel are witnessing a semi-depressed condition. The people have the money to spend, and they are spending large portions of it on furniture, clothing, food, shoes, radios, electrical appliances—products of industries upon which the operations of the iron and steel industry have but little direct influence. In other words, "American business and industry have reached that status of well-being where it no longer has to fear a recurrence of the radical spreads from prosperity to depression that formerly afflicted business and industry in this country."

Behind this increased production per worker through the greater use of power and machinery, behind these new products which have become so essential to the average American well-being, lies the research laboratory, where engineering theories are evolved and brought to practical application, and where more efficient methods and radically new products and processes are discovered. It is here that we really find the mainspring of our long-time guarantees of prosperity.

Today there are a total of about 350 laboratories in the country doing commercial research and testing—143 in colleges, and 207 in commercial enterprises. In these laboratories will be found the men upon whom rests most heavily the future of industry. They are worthy of our most bounteous support. Our success as bankers, industrialists and merchants is bound up in the discoveries and practical applications of Nature's laws as evolved by these engineers, chemists and scientists.

SMALL SAMPLES—NEW EXPERIMENTAL RESULTS

By W. A. Shewhart and F. W. Winters, *Bell Telephone Laboratories, Inc.*

The problem of determining the error of an average of a small sample is merely one of a whole class of sampling problems which belong to the very important and rapidly developing branch of investigation commonly classified as mathematical statistics. The researches in this field, by no means a new one, have received great impetus from the recent work of Pearson, R. A. Fisher, "Student" and others who, within the past decade, have provided the scientific tools which make possible the solution of certain practical problems previously unsolved.

Needless to say, however, all of the important questions in this field have not been answered; and even those that have, very frequently suffer in a practical way from the limitations underlying such answers. Also in some of the recent developments, already referred to, it is not possible to meet in a practical way all of the conditions upon which the theoretical solution rests and hence we must rely to a certain extent upon experimental investigation of the nature offered herein to justify the application of the theory to the practical problems which arise. In fact it is just the effects of such limitations that this paper is to emphasize in such a way, it is hoped, as will indicate that the fruits of future research may be as great or even greater than those so recently obtained.

Specifically we shall do three things:

1. Show the practical necessity for using averages of small samples.
2. Show empirically that "Student's" theory is a marked improvement over customary error theory, and indicate theoretically why even this latest theory fails in most *practical* cases to give the error of the average obtained from a small sample.
3. Show by experimental results that the discrepancy between present theory and practice warrants further theoretical studies.

WIDESPREAD USE OF SMALL SAMPLES

The necessity for knowing how to analyze the results of small numbers of measurements is becoming well established. For example, most physicists and chemists deal with comparatively few observations and many large industrial laboratories carry on routine analyses of raw materials, inspections of product and research investigations where, for one reason or another, often not more than five observations are

made. Many of the properties of materials have been established on comparatively small numbers of widely dispersed observations as, for example, the modulus of rupture of saturated woods of different species where the standard deviation of a set of tests is usually at least 25 per cent of the average of this same set. This is true even though extensive use is to be made of the results.

In the above instances it would be possible to obtain a greater number of observations although sometimes the cost per observation may run into hundreds of dollars. Occasionally, however, it is humanly impossible to obtain further measurements even though we desire to do so. An example would be the design of a levee of sufficient height to hold back the flood waters of the Mississippi. An engineer's estimate would of necessity be based upon the records of the run-off of that area whereas such records have only been maintained for a comparatively few years.[1]

"STUDENT'S" THEORY AN IMPROVEMENT OVER CUSTOMARY ERROR THEORY

Let us review briefly the modern error theory for a sample drawn from a normal universe and then consider the nature of the limitations imposed by this theory. Specifically, customary error theory assumes a set of n observed data constituting a sample to be drawn from a normal universe characterized[2] by equation 1,

$$dy = \frac{1}{\sigma'\sqrt{2\Pi}} e^{-\frac{(X-\overline{X}')^2}{2\sigma'^2}} \quad dX, \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where $\overline{X}'$ and σ' are the mean and standard deviation respectively of the universe, and dy represents to within infinitesimals of higher order the probability of an observed value of X falling within the range X to $X + dX$. It follows, as is well known, that the distribution of means of samples of size n will be given by the same expression where $\frac{\sigma'}{\sqrt{n}}$ is substituted for σ' and the variable X now becomes the average $\overline{X}$ of the sample.

Now, customary error theory uses as an estimate of σ' the following expression calculated from the sample

$$\sigma_1 = \sqrt{\frac{\Sigma(X-\overline{X})^2}{n-1}}, \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

X being measured from an arbitrary origin. Obviously σ_1 may or may not be equal to σ' and in general will be distributed asymmetrically

[1] Still other cases, to be more amply discussed in a future paper, arise where more information can be gained by breaking up a large sample into sub-samples and analyzing the sub-samples upon the basis of modern theory than can be obtained by treating the large sample as a unit.

[2] Throughout this article the *primed* notation is used to represent parameters of the theoretical frequency function, as distinct from the unprimed estimates of these calculated from the sample.

about σ', the lower limit of the distribution being, of course, $\sigma_1=0$. In 1908 "Student" pointed out that, if we use σ_1 as an estimate of true standard deviation σ' of the universe, we can no longer assume that $t=\frac{\sqrt{n}(\overline{X}-\overline{X}')}{\sigma_1}$ will be distributed normally. In the investigation of this problem, however, "Student" actually found the distribution of a slightly different variable $z=\frac{\overline{X}-\overline{X}'}{\sigma}$ where $\sigma=\sqrt{\frac{\Sigma(X-\overline{X})^2}{n}}$, and in this case X is measured from the true mean $\overline{X}'$ of the universe, $\overline{X}$ being the mean of the sample.

The distribution of z is derived upon the following assumptions:

1. That the distribution of means of samples of size n is normal.
2. That the distribution of σ is given by the expression[1]

$$f(\sigma)d\sigma=\frac{n^{\frac{n-1}{2}}}{2^{\frac{n-3}{2}}\left|\frac{n-3}{2}\right.}\frac{\sigma^{n-2}}{\sigma'^{n-1}}e^{-\frac{n\sigma^2}{2\sigma'^2}}d\sigma, \quad \ldots\ldots\ldots\ldots (3)$$

where $f(\sigma)d\sigma$ is to infinitesimals of higher order the probability of occurrence of a value of σ within the range σ to $\sigma+d\sigma$.

3. That $\overline{X}$ and σ of a sample of size n are not correlated.

Papers by "Student,"[2] Pearson,[3] Fisher[4] and others have established the justification of these three assumptions for the case of the normal law and have provided a comprehensive set of tables for estimating the error of the average in terms of the observed standard deviation. Now, we shall consider the application of this theory to some experimental results.

A study of the data obtained from 1000 samples of four drawn from each of three universes, normal, rectangular and right-triangular gives some interesting information as shown in Chart I. The observed frequency distributions of z from the three universes are shown in this figure, but at present we shall confine our attention to the normal case.

The solid curves give the probability (in per cent) of the occurrence of a value of z between $-\infty$ and any assigned value, say z_0. Of course these curves also may be used to give the probability of observing a

[1] Provided we define $\left|\frac{n-3}{2}=\Gamma\left(\frac{n-1}{2}\right)\right.$. ($n$ even.)

[2] "Student," *Biometrika*, Vol. VI, pp. 1–15, 1908; Vol. XI, pp. 416–417, 1917; *Metron*, Vol. V, No. 3, pp. 18–21, 1925.

[3] Karl Pearson, *Biometrika*, Vol. X, pp. 522–529, 1915.

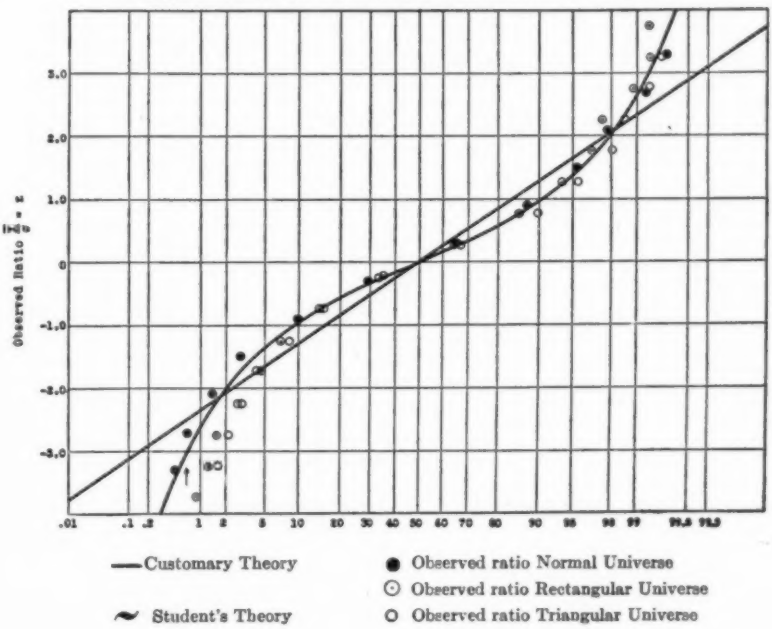
[4] R. A. Fisher, *Biometrika*, Vol. X, pp. 507–521, 1915; *Proceedings of the Cambridge Philosophical Society*, Vol. XXI, pp. 655–658; *Metron*, Vol. V, pp. 3–17 and pp. 22–32, 1925.

value of z between $-z_0$ and $+z_0$. The straight line represents customary theory which assumes that the probability of an observed mean differing from the true mean of the universe by any assigned multiple of the observed standard deviation of the mean, is given by the normal law frequency function. It is clear that the twisted curve representing "Student's" integral gives quite a different result from that obtained by the older theory.

Doubtless anyone acquainted with "Student's" work will recognize

CHART I

PROBABILITY ASSOCIATED WITH RANGE (−∞ TO Z)



at once the essential points of difference between it and normal law theory. The important fact to be noted here is that for small samples like four or five such as often occur in practical problems, "Student's" theory gives a much better representation of the facts than does customary theory.

The black dots represent the observed distribution of z for 1,000 samples of four drawn from a normal universe. We see how closely these dots follow the theoretical curve of "Student" even though the range of the sampled universe was of necessity limited and not infinite as theory assumes. However, does "Student's" theory still apply when the sampled universe is not normal?

Inasmuch as the distribution of z is based upon the three stated assumptions, we naturally would be led to inquire whether these assumptions were still justified when the universe is not normal. The rigorous answer is no, not a single one of them is justified. What then is the effect of the limitations underlying "Student's" distribution?

We give now the theoretical basis for these effects and show later how some of them contribute to the failure of "Student's" theory when, for want of a better method, it is applied to other more general cases than that for which it was intended.

From the work of Tchouproff, Pearson and others as cited in a recent article by Church,[1] we have

$$\sigma'_{\overline{X}} = \frac{\sigma'}{\sqrt{n}},$$

$$\beta'_{1_{\overline{X}}} = \frac{\beta'_1}{n},$$

$$\beta'_{2_{\overline{X}}} = \frac{\beta'_2 - 3}{n} + 3$$

where $\sigma'_{\overline{X}}$, $\beta'_{1_{\overline{X}}}$, $\beta'_{2_{\overline{X}}}$ represent the standard deviation, skewness, and kurtosis of the distribution of means of samples of size n drawn from a universe characterized by σ', β'_1 and β'_2. We see that, as n becomes large, $\beta'_{1_{\overline{X}}} \to 0$ and $\beta'_{2_{\overline{X}}} \to 3$ or the values of skewness and kurtosis corresponding to the normal law. Irrespective, therefore, of the shape of the universe the distribution of means of samples of size n, so far as characterized by the parameters $\beta'_{1_{\overline{X}}}$ and $\beta'_{2_{\overline{X}}}$, approaches normality with a standard deviation $\frac{\sigma'}{\sqrt{n}}$. In the same article by Church, he gives the first four moments of the distribution of the variance σ^2 for samples of size n drawn from any universe characterized by the parameters β'_1, β'_2, β'_3, β'_4 and β'_6. From a study of these it seems that the distribution of σ for universes other than normal may differ materially from that given by equation 3.

Hence, in general, though the first assumption may be approximately fulfilled even for comparatively small values of n, we may not expect the second assumption to be even approximately satisfied except in rare cases. Another important limitation is introduced through the correlation between the mean $\overline{X}$ and variance σ^2 of a sample. Neyman[2] has shown that the average $\overline{X}$ and variance σ^2 are correlated for

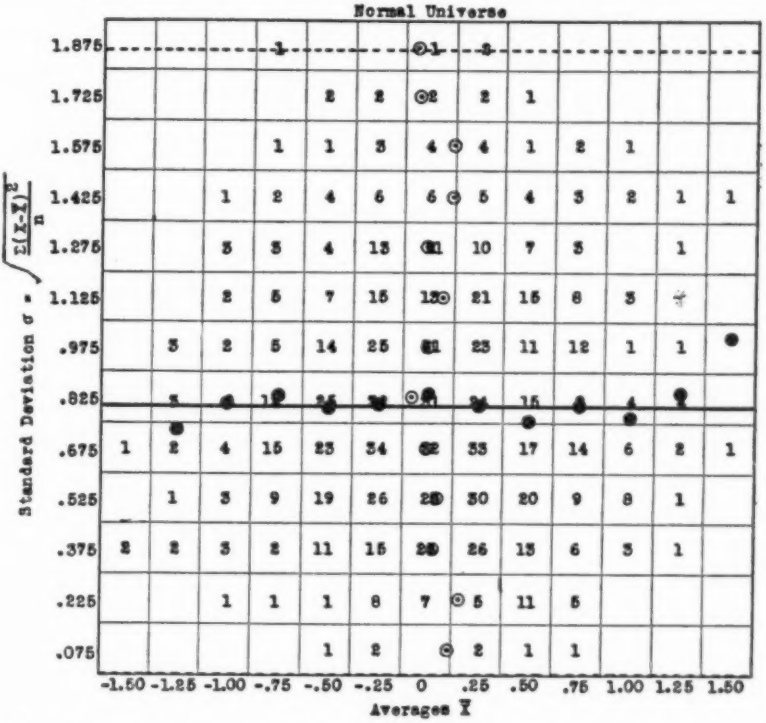
[1] A. E. R. Church, "On the Means and Squared Standard Deviations of Small Samples from Any Population," *Biometrika*, Vol. XVIII, pp. 320–394, November, 1926.

[2] J. Neyman, "On the Correlation of the Mean and Variance in Samples Drawn from an Infinite Population," *Biometrika*, Vol. XVIII, pp. 401–413, 1926.

all samples drawn from other than a normal universe. Moreover, in practice even though we know the universe to be normal in appearance it nevertheless embraces only a finite range. Hence we must always expect correlation between the mean $\overline{X}$ and variance σ^2, *i. e.* even "Student's" theory probably never rigorously applies to a practical problem.

CHART II

CONTROL CHART TAKING INTO ACCOUNT THE CORRELATION BETWEEN STANDARD DEVIATION AND AVERAGES FOR SAMPLES OF 4

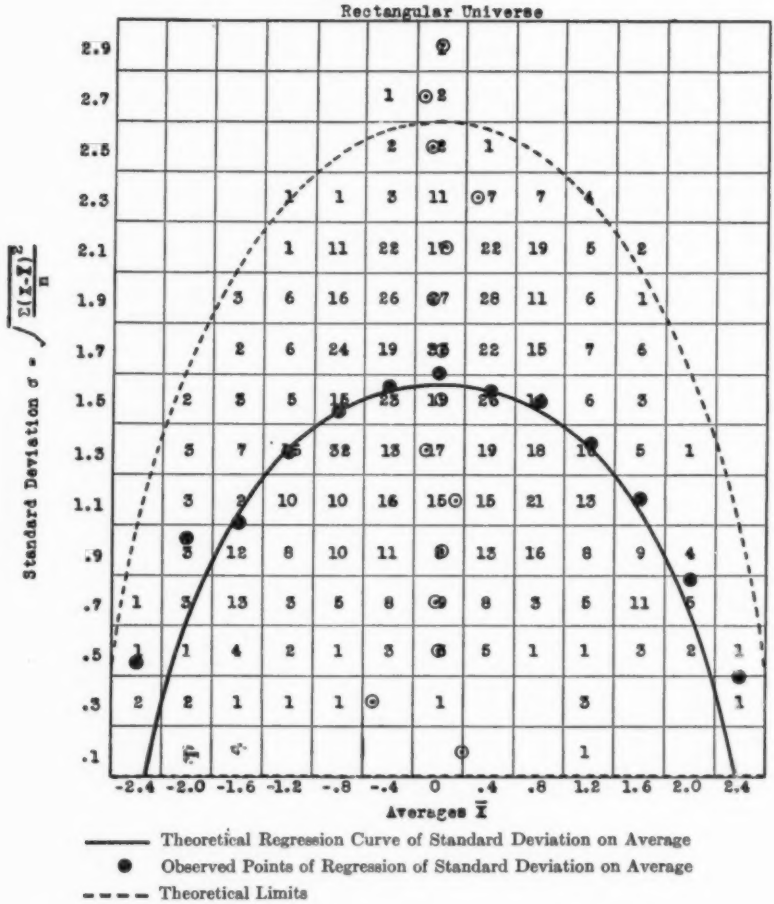


The truth of this statement becomes evident when we study the regression[1] of standard deviation on average for the three universes as shown in Chart II. Even in the case of the normal universe there seems to be some correlation between σ and $\overline{X}$, at the ends of the range of averages. This is to be expected, however, since the range of the experimental normal universe, as also of the other universes was of necessity limited. The dotted limit lines theoretically should include 99.7 per cent of the observations.

[1] The curves of regression were constructed following the methods described by Neyman. We are indebted to Miss Marion B. Cater and Miss Miriam S. Harold for carrying out the experimental work and making all calculations.

For samples from universes characterized by values of β'_1 and β'_2 satisfying the relation $\beta'_2-\beta'_1-3=0$, the regression of variance on the mean is linear. For samples from universes with β''s lying above this line, the regression to the first order of approximation is parabolic with

CHART II (*Continued*)

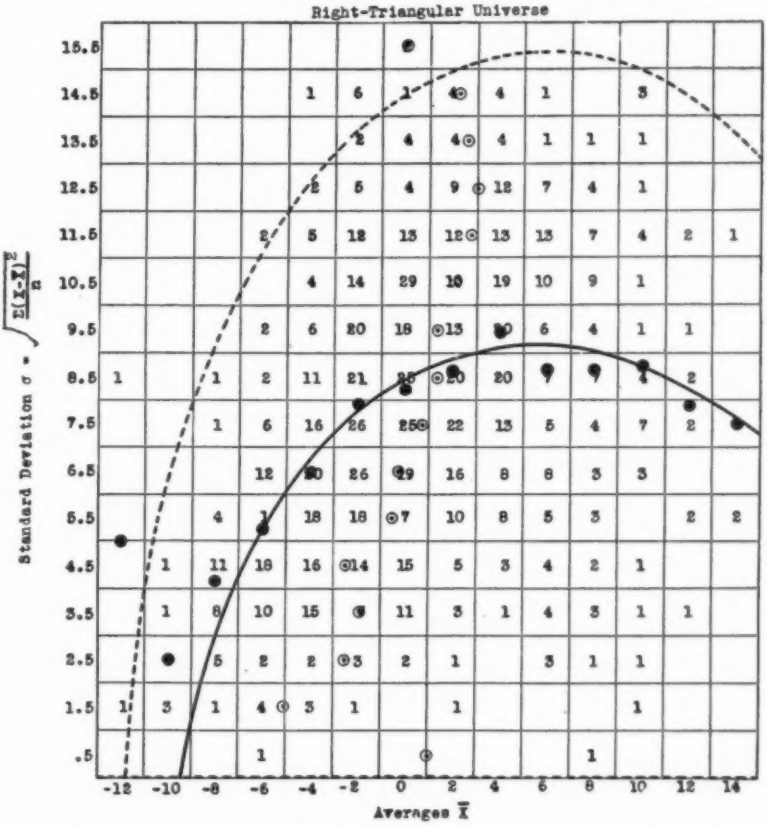


branches directed in the negative sense (downward), and for samples from universes with β'_1's lying below this line, the branches of the parabola are directed in the positive sense (upward). The universes chosen for study are examples of the first two types of regression.

The effect of this correlation upon the distribution of $z=\frac{x}{\sigma}$ where $x=\overline{X}-\overline{X}'$ becomes evident. For linear regression we would expect the distribution to be skew and therefore not the same as that given by

"Student." For the first of the two above-mentioned types of non-linear regression, "Student's" integral will give probabilities corresponding to a given range of z which are too high and, for the second type of non-linear regression, "Student's" integral will give probabili-

CHART II (*Continued*)



ties which are too low, provided in each case that both assumptions (1) and (2) are met.

We present now some empirical evidence to serve as a background for the above statements as well as to show in picturesque form the failure of even the best available theory.

EMPIRICAL RESULTS SHOWING IMPORTANCE OF FURTHER RESEARCH

Since in practice the three stated assumptions are, strictly speaking, never met, we have no general way of determining how closely "Student's" integral will give the distribution of z. We are obliged, therefore, at the present time to analyze the situation empirically.

The dots ⊙ and ○ in Chart I represent the observed distribution of z for 1,000 averages of four drawn from the rectangular and right-triangular universes respectively. Apparently the effect of the correlation is the controlling factor in these two cases. At least the results are as would be expected, since β'_1 and β'_2 for each of the two non-normal universes lie above the line $\beta'_2-\beta'_1-3=0$. The observed distributions of means and of standard deviations obtained from samples of four drawn from the rectangular universe are very much like those of the means and standard deviations of samples drawn from the normal universe. Assumptions (1) and (2) are, therefore, approximately met in this case whereas a glance at the regression between x and σ for this universe will suffice to show that assumption (3) is not even approximately fulfilled. We note that as x increases in absolute value the corresponding average value of σ decreases, which means that $z=\frac{x}{\sigma}$ increases. The significance of this fact is that a greater number of z's will lie outside a certain $|z|$ (the curve of regression of σ on x being approximately symmetrical) than is the case for the z's from a normal universe where the average value of σ for a given x is practically constant.

In terms of "Student's" integral we may, therefore, state, with some confidence, that the value obtained from the integral for the range $-z$ to $+z$ is too large, at least for most values of z between 0 and 3. The physical significance of this fact is seen in the arrangement of the dots ⊙ relative to "Student's" curve, that is they are on the concave side of the latter and therefore subtend between the range $-z$ to $+z$, a smaller probability than that indicated by "Student's" theory, *i. e.* the range[1] corresponding to a given probability as given by "Student's" theory is too small.

How is it for the case of the right-triangular universe? The observed distributions of means and standard deviations of samples drawn from this universe are quite similar in appearance to the corresponding distributions from the rectangular universe. The curve of regression of σ on x for this case is in general character like that for the rectangular universe only not so symmetrical. What was said about z, as the value of x increases in the rectangular, may be repeated in general for this case, particularly for those z's corresponding to negative values of

[1] A still more important problem than that described in this paper has to do with the expected probability associated with the range given by $\overline{X}\pm t\sigma_{\overline{X}}$ where

$$\sigma_{\overline{X}}=\sqrt{\frac{\Sigma(X-\overline{X})^2}{n^2}}.$$

Empirical information obtained from 150 observations shows that this probability is approximately 92 per cent when $t=3$.

x. On the positive side the average σ for a given x does not decrease so rapidly as x increases and we would, therefore, expect a closer agreement between "Student's" curve and that of the observed z's when the latter are positive. The position of the dots ○ relative to "Student's" curve over the observed range seem to agree very well with what we might expect from such a study of the regression curve. Here then as in the rectangular case we feel justified in concluding that "Student's" integral for the probability of an observed value of z falling within the range $-z_0$ to $+z_0$ is too large, at least for most values of $z_0 \leq 3$, *i. e.* the range associated with a given probability as indicated by "Student's" theory is too small.

In the light of the theoretical and empirical results here presented it seems likely that the probability associated with a given range $-z$ to $+z$ as given by "Student's" integral must be considered as an upper bound. In other words, the range associated with a given probability as given by "Student's" integral must be considered as a lower bound when sampling from a universe whose β''s lie above the line $\beta'_2 - \beta'_1 - 3 = 0$.

SUMMARY

In closing let us describe briefly the ideas we have attempted to convey. We have the practical problem of estimating the error of the average obtained from a small sample. For the case of sampling from a normal universe the empirical results here presented show that "Student's" theory applies even though assumptions (1), (2) and (3) are, strictly speaking, not met because of the physical limitations of any universe such as must be used to check theory.

For the case of sampling from a non-normal universe, we have pointed out the theoretical reasons for the failure of "Student's" theory. The empirical results show that the correction that may be necessary, if we attempt to apply "Student's" theory, when sampling from other than a normal universe is of sufficient magnitude to warrant further extension of theory to cover the cases which arise in practice.

THE INDEX OF VOLUME OF TRADE: SECOND REVISION

By Carl Snyder, *Federal Reserve Bank of New York*

In the first presentation of the new index of total Volume of Trade, in this Journal five years ago,[1] the purpose as well as the difficulties involved in the enterprise were set forth in detail. It was, first of all, an attempt to gather together the great variety of new material which has become available mainly in and since the War; and, secondly, to make use of new methods in the measurement of trade fluctuations.

The new material was chiefly of two sorts: First, a much wider variety of data as to basic production, and especially much new material as to the production of goods for immediate consumption. This permitted a division of the production series into two composites of "producers'" and "consumers'" goods, thus providing an escape from the dominating influence of a few great basic products, hitherto the chief series available, which had so largely shaped and, as the writer believes, so seriously distorted our conceptions of the business cycle.

Second, the new material included such data as that relating to wholesale and retail trade, department store, chain store and mail order sales, compiled by the Federal Reserve Board, representing a field for which any kind of accurate information had hitherto been lacking; and likewise a variety of new series covering such subjects as electric power production, life insurance, advertising, telephone toll service, grain and cotton future sales, postal receipts, the new series of car loadings divided as to character of traffic, etc.—all of which provided a salutary check on the persistent use of the production series as measures of *trade*.

In addition, the plan included an endeavor to restore to their pre-war value and comparability a number of series, in dollar values, such as bank clearings, building permits, etc., which had quite lost their utility as business barometers, owing to the violent upheaval in prices in and since the War.

In the original index there were included some 56 independently computed series (really 58), affording a wide and representative sampling of the whole field of production, primary and secondary distribution, financial and even speculative activity, and general trade. These were presented in the form of percentage deviations from the computed normal rate of growth or trend of past years, thus providing a simple and easy method of putting these diverse series together in a weighted

[1] This Journal, Vol. XVIII, p. 949, 1923.

composite, expressing the variations in the nation's trade from that steady and ceaseless growth which is its most salient characteristic. The difficulties and obstacles of this undertaking, of calculation of the trends of growth, of seasonal changes and, in the case of the dollar series, the variations in prices in each particular series, were not minimized. On the contrary, it was expressly stated that:

> The results here shown are presented simply as first approximations and nothing more. The purpose is to revise the index for all of the series each year in the light of such new information as may be available as to seasonals, the computation of normal growth, price changes, and the like.

The first of the promised revisions was given in this JOURNAL for September of 1925, with the inclusion of one or two new series, such as real estate transfers in 41 cities; and the difficulties and limitations of the method further discussed, in detail. The second revision here presented includes a larger number of new series, representing chiefly a widening of the two production groups; and a new and significant series as to the number of incorporations of new enterprises.

Substantially, however, the method and the general results remain unchanged. Every series has been gone over painstakingly, in the light of two or three years of additional experience which, in the case of data of recent origin, has been highly instructive. Some of the series, as exports and wholesale trade, have been split up into further divisions and then recombined in the endeavor to obtain closer approximations; and there has been a slight shift in the weightings as described below. But in general the changes shown are slight and have affected but little the broad composite.

Substantially the findings of five years ago remain, that the variations in trade from its normal or long-time rate of growth are nothing like so wide as had been so generally assumed theretofore, and that, as good theory would suggest, the flow of goods to the final consumers, the varied and intensive product of a highly diversified and mighty nation, goes on, for the most part, with an astonishing evenness and a steadiness of growth that almost alone provides us with foreknowledge of the future.

The main changes in the new series are as follows:

The employment series now used is the composite covering 33 industries, compiled by the Federal Reserve Board at Washington. It is true that the employment figures are chiefly for factories and these for different states tend to run together quite remarkably. It nevertheless seemed somewhat safer to take the broader composite now available rather than the excellent sampling provided by the New York State figures.

In the last two or three years public construction of all sorts, municipal and state work, roads, bridges, etc., have come to occupy a much larger proportion of the total of building than hitherto. This type of construction has shown a heavy and perhaps unhealthy increase, while private construction, best represented by building permits in the cities, has tended to decline. Nevertheless, for the purpose of gauging the total of the nation's activities, it seems evident that the total of building contracts, as compiled by the Dodge Company, is now a much more comprehensive series than even the broadest of the compilations as to building permits. Total contracts have, therefore, been substituted for the previous series.

Another more inclusive series is the compilation as to wholesale trade now made available for the larger part of the country by the Federal Reserve Board. This has been substituted for the wholesale trade reported for the New York Federal Reserve district alone. Although the latter is highly representative of the broader composite, again it seems safer to take the most inclusive series available rather than a lesser sampling.

In making allowance for price changes in this series, the data have been divided into three groups of clothing, textiles, etc.; wholesale groceries and meats; and furniture, drugs and miscellaneous items; and separate computation made as to the trends of each of these divisions. The final series given is a composite of these three independent computations.

Likewise, exports have now been divided into three groups of crude materials, food exports, and manufactured exports, instead of into two groups as heretofore, and separate computations made as to each of these individual series.

A new major series included is that of the number of incorporations of new companies in New York State, believed to be an excellent sampling of this quite important barometer, for the nation at large.

Finally, 13 new series have been added to the two groups of production, making a total of 43 series in all. These, as heretofore, have been divided into the producers' and consumers' types of goods.

This brings the number of independently computed series in the broad composite up to 75, as contrasted with 58 in the original compilation; but of these only 71 computations are here shown. These represent practically all the material of what may be termed national significance now available monthly in time for inclusion in this index. Certain series as, for example, railway freight ton mileage, are available only at such late date; and much greater detail is available from the weekly car loadings. From these we may segregate the relatively

smooth movement of merchandise and manufactured goods from the erratic and highly seasonal movement of the basic products, such as coal, grain, cotton, lumber and the like.

In view of the fact that a much broader sampling is now possible as to the production of consumers' types of goods, this division has been given an equal weighting with that of producers' goods. The employment series, none too satisfactory in its significance and difficult of interpretation, has been reduced to a weight of 4 per cent, while the broader series of total building contracts has been raised to 5 per cent.

Wholesale trade, now clearly of diminishing importance, with the enormous growth of chain store systems and department stores buying direct, has been reduced to 5 per cent; imports have been increased to 3 per cent, and so also have car loadings of basic products.

Chain grocery sales have been reduced to 5 per cent; sales on the New York Stock Exchange to 1 per cent; and New York City debits, so heavily influenced by the volume of financial transactions, to 4 per cent. This has permitted an increase in the weight of electric power production, a series of rapidly growing significance, to 4 per cent;

	Weights	Group weights
Productive activity		
1. Producers' goods (22 series)	9	
2. Consumers' goods (21 series)	9	
3. Employment	4	
4. Building construction	5	
5. Motor cars and trucks (2 series)	2	29
Primary distribution		
6. Car loadings, miscellaneous merchandise	5	
7. " " other	3	
8. Wholesale trade (3 series)	5	
9. Exports, crude materials	1	
10. " food	1	
11. " manufactures	2	
12. Imports	3	
13. Panama canal traffic	1	21
Distribution to consumer		
14. Department stores	8	
15. Chain stores	3	
16. Chain groceries	5	
17. Mail order houses	3	
18. Advertising (2 series)	2	
19. Life insurance	2	23
Financial		
20. New securities	2	
21. Stock sales	1	
22. Grain sales, future	1	
23. Cotton sales, future	1	5
General business		
24. Postal receipts	1	
25. Communication	2	
26. Electric power	4	
27. Corporations formed	1	10
28. Real estate transfers	2	
29. New York City debits	4	
30. Debits outside New York City	8	12
	100	100

telephonic communication to 2 per cent; and new incorporations have been given a weight of 1 per cent.

The 30 major series as now constituted, with their separate weights, now stand as shown in table on the preceding page.

The two production groups, including 43 separate series and given a weight of 18 per cent in the Composite Index, now stand as below:

Producers' goods	Weights		Consumers' goods	Weights	
Iron and steel			*Meat*		
1. Pig iron	7		1. Hogs slaughtered	9	
2. Steel ingots	20	27	2. Cattle "	6	
			3. Sheep "	1	
Textiles			4. Calves "	1	17
3. Cotton consumption	11				
4. " movement	5		*Farm produce*		
5. Wool mill activity	6		5. Farm produce shipped	10	10
6. Silk consumption	4	26			
Fuels			*Grain*		
7. Petroleum	7		6. Wheat receipts	4	
8. Gas and fuel oil	2		7. Corn "	2	
9. Lubricating oils	1		8. Oats "	1	7
10. Bituminous coal	5				
11. Coke	1	16	*Other food*		
			9. Flour milled	8	
Lumber			10. Sugar meltings	4	
12. Lumber	8	8	11. Lard and cottonseed oil	3	15
Nonferrous metals			*Fuel and light*		
13. Copper	6		12. Gasoline	8	
14. Lead	3		13. Anthracite coal	3	
15. Zinc	1		14. Kerosene	1	12
16. Tin deliveries	1	11			
			Printing		
Miscellaneous			15. Newsprint	10	
17. Sole leather	2		16. Printing activity	5	15
18. Railroad equipment	2				
19. Cement	2		*Tobacco*		
20. Total paper	4		17. Tobacco and snuff	3	
21. Wood pulp	1		18. Cigars	2	
22. Ship building	1	12	19. Cigarettes	4	9
		100	*Miscellaneous*		
			20. Boots and shoes	7	
			21. Tires	8	15
					100

Within the last year one problem has arisen which had not heretofore been noticeable. That is a rather striking difference between the trend of financial activity and many phases of physical activity, most notably in physical production. The result of this has been that for the first time in the nine years which the index covers, there has been a difference in the last year of from 2 to 3 points, and latterly 3 to 4 points between the weighted composite of the 75 series, as here shown, and this same composite with the group called "Financial Activity" left out. This difference obtains although the weight of this financial group has been reduced to 5 per cent.

This fairly indicates what seems the greatest difficulty in the construction of an index of total trade. It is not that the method presents

possibilities of gross distortion and error, as was true in former times when the number of available monthly series was extremely small and the most of these, like our old friend pig iron, of a highly variable sort. The real difficulty is the smallness of the variations in so many of the series and, therefore, undue effect of variations in a few widely moving series.

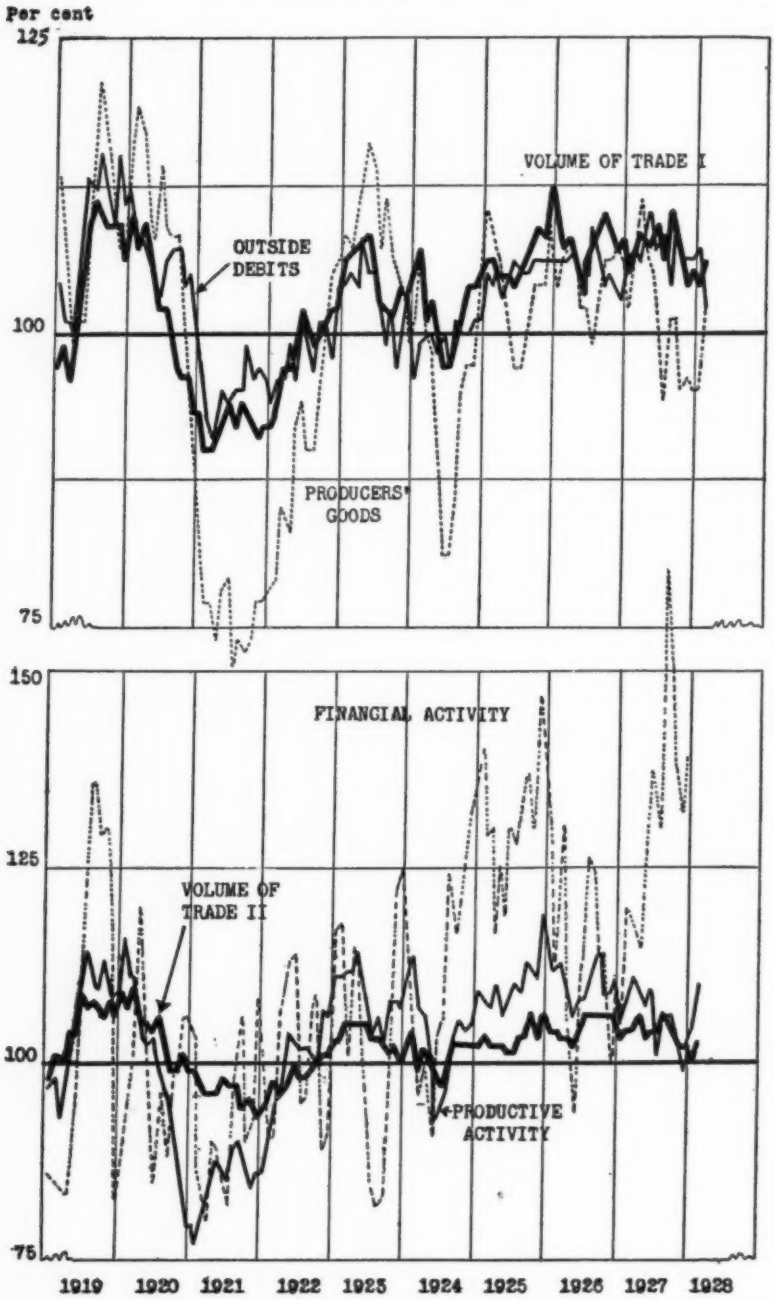
It is here no question of differences of 10 or 15 per cent, to say nothing of the wild estimates still prevalent up to a few years ago; but differences of 2 to 3 per cent. This in itself serves to enforce the conclusions originally reached that the variations in the total trade of the country, even at the extremes, are nothing like what they were once supposed to be.

There still remains the high degree of correspondence between the weighted composite and the index derived from debits in 140 centers outside of New York City, as is set forth in the first of the graphs shown. There was a period of divergence at the end of 1920 when debits outside New York held up longer than did the composite, owing very largely to the disastrous slump in physical production and the heavy influence that this had upon the composite index.

It is open to question whether the debits index is not a truer index of the broad general trade of the country than any kind of an index which includes, with any heavy weighting, the elements of basic production. It is basic production which varies widely, rather than the general trade of the country as expressed in the flow of goods to the final consumers.

This is now so clear that it seems as if it would be a great gain if we could have an index of trade quite divorced from production. In order to disclose the difference in the movements between general trade and the production series, we have computed a new composite which excludes the group of productive activity and likewise that of financial activity, and of debits in New York City. This recomputation still includes 62 per cent, by weight, of the index of total trade. With this, in the second graph, are given for comparison two of the three excluded groups.

It is obvious, of course, that the production and sale of basic materials, to say nothing of building construction, motor cars, etc., in themselves give rise to a heavy volume of exchanges, that is to say, of "trade." It is likewise true that the growth of the country cannot go on without heavy capital expenditure and therefore that the issue of new securities is just as much a part of the trade of the country as the actual sales of merchandise or receipts from real estate transfers, life insurance, vacation travel, and all the rest. Further, even speculation is a vital element in trade since it contributes to liquid and easy flowing



The upper chart shows the Index of Volume of Trade in comparison with two components; the lower shows the Volume of Trade ex productive and financial activity in comparison with these two latter components.

markets, promotes savings (often involuntary), and by the bank loans created for this speculation supplies business with low-priced credit.

A comprehensive index of trade will therefore include reports from every available type of economic activity. But it is of interest to have some measure revealing the steady and even tenor of general trade as contrasted with the wider variables.

Just as there is much variance in opinion as to what may properly be termed a measure of trade, so also there remain reservations as to the methods of calculation and presentation. To a large extent these latter remain as a carry-over from the almost inevitable use of a fixed base in our price indexes.

It is perfectly true that the calculation of the trend of growth is often a difficult matter and at times practically a question of arbitrary choice. But, one way or another, some such calculation *must* be made. It may happen that our price indexes will run on for a generation or more with apparently little change, though usually after a given time there will be a general disposition to bring the reference base year "up to date." But in the price index there is no element of growth, nor does even the longest historical trend give the least suggestion of what may reasonably be expected for another year or even another month.

In practically all trade and production series this growth factor is *the most persistent trait*, far more so in the majority of cases than the fluctuations. It follows, therefore, that this growth element must be allowed for or eliminated, else the fluctuations have little meaning. We may do this mentally or statistically. One way or another it must be done in any intelligent estimation of the position of an industry or of trade in general. For my own part I prefer the graphic method and carefully calculated trend lines, based upon a full review of all the available evidence, to the stumbling calculation that one must make mentally with the figures. In the one case I get a vague impression. In the other, the whole trend of the industry leaps to the eye.

Needless to say, the statistical method has its limitations. Much depends upon the judgment with which the period of calculation is selected. Sometimes an arbitrary choice must be made. But the difficulties are no greater than the limitations of the figures and the facts themselves. The method is, indeed, little more than a swift and highly graphic shorthand. As to the calculation of index numbers based upon these trends of growth, simple percentages of deviation, this seems nothing more than making a measurement which the eye or the mind must make in any event, whether we are dealing with raw figures or with calculated trends.

Far more perplexing for the most part is the calculation of the

seasonal change. In a great number of instances, at least, these calculations represent little more than an exasperating and futile attempt to reduce irregularities to index numbers. Every one who has worked in this field knows that in a number of important series there has been a definite change in these seasonal relations, sometimes subtle, sometimes radical. Who shall predict when these changes cease or find a method of predicting further change?

In our own practice the elaborate calculation of scatter has come to be preceded by a simple and expeditious device; that is to plot the data, for the last five or six years, with each month in a vertical column, so that the lines for each year fall one below the other. If the lines wave together generally, so that the seasonal swings are obvious to the unaided and unimaginative eye, it may then follow that the measurement of these changes may be profitably undertaken; otherwise not, because if an obvious and consistent seasonal range in recent years is not thus discoverable, it seems of little worth to go further. Of what use is an index of seasonal change which may be but a confused average of diverse tendencies, if it have little relation to recent reality?

With all these reservations and, let us hope, with a clear understanding that all index number compilations, whether of price indexes, production indexes or any other, are at best simply useful approximations and no more, it seems to the writer that we now have practically as complete and trustworthy an index of trade in all its forms as we are likely ever to have. What remains outside of the present calculations is of relatively small consequence, and, as I have remarked before, complete or "astronomical" knowledge could change the result in no material way.

With these new computations, and the equally detailed data on the monetary and credit side, it seems as if we should now have as clear an insight into the nature or "causes" of the business cycle as perhaps we shall ever have. These conclusions will be set forth in another paper.

The index numbers of the three composites are given below. A sheet containing the indexes for each of the major series will be sent upon request.

VOLUME OF TRADE INDEX*

(100=computed normal)

I. TOTAL VOLUME OF TRADE

(All groups, 75 series)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Av.
1919	97	99	96	101	104	109	111	110	109	109	109	106	105
1920	110	107	109	105	103	102	102	100	97	96	96	93	102
1921	93	90	90	92	93	94	92	94	93	92	91	92	92
1922	92	93	97	97	100	102	100	99	100	101	102	102	99
1923	106	106	107	107	108	105	102	102	101	102	104	103	104
1924	105	107	101	103	99	97	97	99	103	104	104	105	102
1925	106	106	105	105	105	104	105	107	108	109	108	112	107
1926	109	107	108	106	103	106	108	109	110	108	107	108	107
1927	105	107	108	108	107	108	106	110	109	106	104	105	107
1928	104	107	...	...	...	...	...	...	...	...	...	...	...

II. GENERAL TRADE (Excluding productive and financial activity groups, and New York City debits; 62 per cent of total)

1919	98	101	100	104	104	109	107	108	107	106	108	106	105
1920	109	107	110	105	105	104	106	103	99	99	101	99	104
1921	99	97	96	96	96	98	97	97	94	95	94	93	96
1922	94	95	98	96	97	100	98	98	100	100	101	101	98
1923	103	103	105	105	105	105	103	103	102	101	102	100	103
1924	102	104	99	102	99	98	97	98	102	102	102	102	101
1925	102	103	102	102	102	101	101	103	103	106	103	106	103
1926	104	104	103	103	102	104	106	106	106	106	106	106	105
1927	103	104	104	106	103	104	104	106	105	103	102	102	104
1928	100	102	...	...	...	...	...	...	...	...	...	...	...

III. GENERAL TRADE AND PRODUCTION (Excluding financial activity and New York City debits; 83 per cent of total)

1919	97	100	97	103	104	108	109	108	107	108	107	107	105
1920	111	108	110	104	104	104	103	101	97	95	95	92	102
1921	92	91	91	93	93	94	93	94	92	92	90	90	92
1922	91	93	97	96	100	101	99	99	100	100	103	103	99
1923	106	105	108	107	108	106	104	105	103	104	104	102	105
1924	105	108	102	103	100	96	96	97	102	104	103	103	102
1925	104	105	103	105	103	102	104	105	107	108	106	110	105
1926	107	107	106	105	103	105	106	108	110	107	107	108	107
1927	104	106	106	106	104	106	102	106	105	102	101	101	104
1928	101	105	...	...	...	...	...	...	...	...	...	...	...

* The revision and compilation of this index has been the work of Alice L. Carlson, B. P. Chambers, Lucile Bagwell, Nancy McLeod, Leroy M. Piser, and Robert G. Cowan, of the Reports Department, Federal Reserve Bank of New York.

THE GRAPHICAL CONSTRUCTION OF MOVING AVERAGES

By Ruth McChesney, *University of California*

The search in statistics is for "simplicity"—both in methods of actually working the computations and in the interpretation. So often the usefulness of the most simple concepts is little understood merely because their meaning has not been thoroughly thought through to a proper conclusion. The full significance and the extreme simplicity usually come only after much hard labor, and then deserve to be shared with others employed in similar tasks.

Very gradually, the general usefulness of moving averages has been growing in importance in the statistical analysis of complicated economic data, particularly in time series. Up to rather recent times moving averages were usually considered merely as a means of eliminating the longer-period cycle in a series of data in order to secure a relatively straight trend. For instance, a seasonal cycle could be eliminated by taking a twelve-months moving average. This method obviously necessitates the assumption of a constant cycle which, as a matter of fact, seldom seems to be justified and consequently is open to much criticism. However, moving averages have an entirely different function, that of merely creating a smoothed fluctuating curve. In this case the average is derived for a short period of two or three months. Furthermore, there is an added value of securing the moving average of the moving average, termed the "twice iterated average." Its advantages are two-fold in that it is a further smoothing of the curve in eliminating irrelevant short-time deviations, and it more nearly approaches the true trend for it is, in reality, a weighted five-months moving average having the expression $\frac{A+2B+3C+2D+E}{9}$, where A, B, C, D, and E are the several values of the ordinates as indicated in Chart I. The significance of this expression will become evident when considered in the light of the following discussion. Successive moving averages of these iterated averages in turn may be termed "three times," "four times," and "n-times" iterated moving averages.

It is with this conception of the moving average in mind, that the present discussion is undertaken in order to simplify the work of computation and to offer suggestions as to the significance of the moving average in relation to the original data. To all persons engaged in the actual mechanical operation of the computations, the calculation

of the above suggests a long, tedious process. Therefore, it is essential to discover some quick and simple method whereby the amount of work of computation may be decreased to a minimum.

The method proposed in this paper is entirely a graphical one and requires no arithmetical computations whatsoever. Its advantage lies in the fact that the work of computing and of graphically representing the results has been reduced to a single step, and the graph is in such a form that a complete comparison stands out most clearly between the several successive averages and the original series.

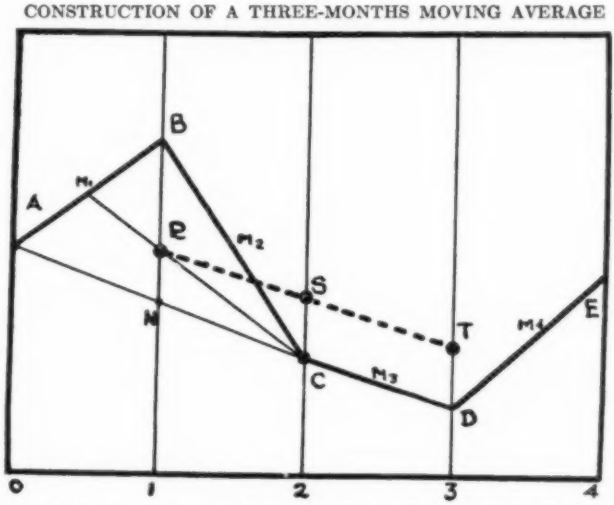
In general, it has been found that in a time series, a two- or three-months moving average, preferably three-months, is the most convenient period, for it is possible to produce in two smoothings with the three-months period what would require four smoothings in a two-months period. However, a discussion pertaining to the different lengths of periods shall be considered later, but for convenience the analysis will be based on the three-months moving average.

GRAPHICAL CONSTRUCTION OF THE MOVING AVERAGE FOR A THREE-MONTHS PERIOD [1]

The purpose of this method is to locate graphically the value equivalent to the average of the three points, A, B, and C which is shown in Chart I to be "R." To simplify the concept, consider that the

CHART I

CONSTRUCTION OF A THREE-MONTHS MOVING AVERAGE

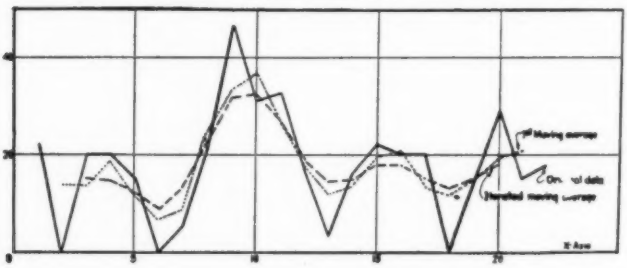


[1] It is the writer's desire to express appreciation to Dr. Ragnar Frisch, Assistant Professor of Economics, University of Oslo, Oslo, Norway, for his very generous interview while visiting the United States, for it was his suggestions as to the possibilities of graphically constructing moving averages for three-year periods that has led to the development of the concise and more rapid method that is described in this paper.

points A, B, and C are connected to form a triangle. Locate R on the B, or intermediate ordinate as the intersection point of a line connecting the mid-point of one of the other sides of the triangle to its opposite apex; *e. g.* the median $\overline{MC}$. It will be recalled from geometry that this point of intersection divides the medial line two-thirds the distance from the apex, by the theorem that the medians of a triangle are concurrent in a trisection point of each. This point is labeled R in the figure.[1]

CHART II

GRAPHICAL REPRESENTATION OF THE MOVING AVERAGE AND THE REITERATED AVERAGE UPON THE ORIGINAL DATA



With the method and proof as described one has the basis of many short cuts in the general graphical process. Obviously, it becomes unnecessary to draw in the lines connecting every second point, for the mid-point of the lines connecting each successive point is sufficient to locate the trisection point on the intermediate ordinate. The simplest process is to connect the original values by pencil lines. Upon this curve, it is necessary to locate only every other mid-point of these lines because the median lines of any of the three sides of the triangle all intersect at one point. Having plotted these points of intersection which are the ordinates of the moving average, they may be connected

[1] It is still to be proved that this trisection point of the medians is equivalent to the average of the three points A, B, and C or $R=\frac{A+B+C}{3}$. By definition of the moving average, the value of that average must be plotted on the middle ordinate. This is the median $\overline{NB}$. By considering Chart I, it will be seen that, since $N=\frac{A+C}{2}$

$$R=\frac{B-N}{3}+N=\frac{2N+B}{3}=\frac{A+B+C}{3}.$$

Thus it is apparent that the point, R, obtained, is the average of the ordinates A, B, and C. In a similar manner, S and T may be located as the average of the points B, C, D, and C, D, E, respectively, having the equations

$$S=\frac{\frac{2(B+C)}{2}+D}{3}=\frac{B+C+D}{3}$$

$$T=\frac{\frac{2(C+D)}{2}+E}{3}=\frac{C+D+E}{3}.$$

The same process may be carried throughout the series and, as is seen in Chart II, results in a relatively smoothed curve.

by a line of another color and compared with the original series in pencil.

THE REITERATED AVERAGE

To secure the reiterated average, the same process is carried out upon the moving average instead of the original series. An illustration of the significance of the reiterated average as a means of further smoothing the data may also be seen in Chart II. Each successive average slowly approaches the general mean but still adheres very closely to the general shape of the curve because of the weighted character of the average as is evident in the following expression:

"Twice" iterated moving average =

$$\frac{\frac{A+B+C}{3}+\frac{B+C+D}{3}+\frac{C+D+E}{3}}{3}=\frac{A+2B+3C+2D+E}{9}.$$

"Three-times" iterated moving average =

$$\frac{\frac{A+2B+3C+2D+E}{9}+\frac{B+2C+3D+2E+F}{9}+\frac{C+2D+3E+2F+G}{9}}{3}=$$

$$\frac{A+3B+6C+7D+6E+3F+G}{27}.$$

CONSTRUCTION OF GEOMETRIC AVERAGES

The explanations that have been presented have assumed the use of the ordinary arithmetic coördinate paper. Obviously, the results so obtained are the arithmetic means. However, if the values when plotted seem to show a trend of a constant relative increase, it may seem advisable to plot them on semi-logarithmic paper. The averages of the logarithms of the original values are the geometric averages of the antilogarithms. In this manner, it is obvious that geometric means or geometric moving averages may also be very simply computed graphically.

THE GRAPHICAL REPRESENTATION OF THE TWO-MONTHS AVERAGE

Heretofore, the discussion has dealt entirely with the three-months moving average. However, graphical computation of averages for other lengths of period is possible and relatively simple. Nevertheless, in constructing the two-months average the process of smoothing is so slow that it seems almost impractical. The value of the ordinate for this average is the mid-point of the line connecting every point and is expressed mathematically as

$$\text{Two-months average} = \frac{A+B}{2}.$$

An example of this type of average is brought out in Chart III, and may be compared with results obtained with the three-months period of

CHART III

GRAPHICAL ILLUSTRATION OF THE MOVING AVERAGE FOR A TWO-MONTHS PERIOD

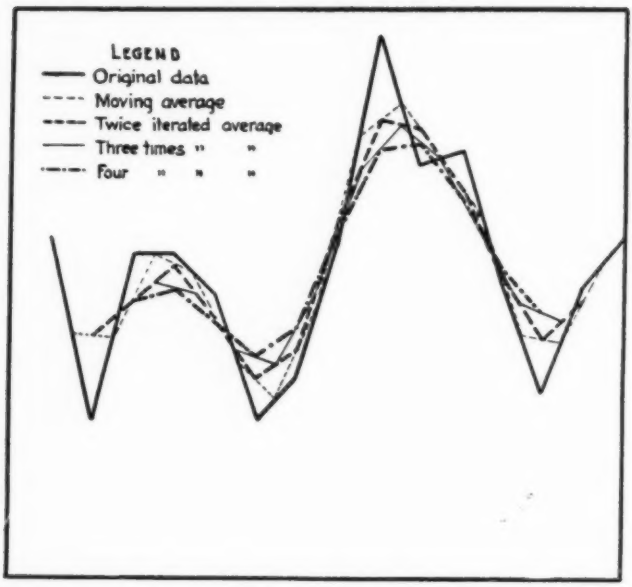


Chart II, the latter requiring nearly one-half the work for computation. The four-times-iterated two-months moving average in Chart III may be shown to have the mathematical derivation as follows:

$$\frac{\dfrac{\dfrac{A+B}{2}+\dfrac{B+C}{2}}{2}+\dfrac{\dfrac{B+C}{2}+\dfrac{C+D}{2}}{2}}{2}+\frac{\dfrac{\dfrac{B+C}{2}+\dfrac{C+D}{2}}{2}+\dfrac{\dfrac{C+D}{2}+\dfrac{D+E}{2}}{2}}{2}}{2}$$

$$=\frac{A+4B+6C+4D+E}{16}.$$

GRAPHICAL CONSTRUCTION OF MOVING AVERAGES FOR PERIODS GREATER THAN THREE MONTHS

For periods greater than three months, the graphical construction is still possible and relatively simple. With the construction of the seven-months average, however, difficulties arise with the introduction

of complicated lines. It is to describe briefly the method of the construction of these averages that the following paragraphs are included:

1. *The Four-Months Average.* The four-months average may be plotted as the mid-point of the line connecting the average point of the first two values (the mid-point of $\overline{AB}$) and the average point of the third and fourth values (mid-point of $\overline{CD}$). In other words, the four-months average is the point at which this intersecting line, $\overline{M_1M_3}$, crosses the middle ordinate of the four values. An illustration is seen in Chart IV_A, the mathematical expression of which may be written as follows:

$$R=\frac{\frac{A+B}{2}+\frac{C+D}{2}}{2}=\frac{A+B+C+D}{4}.$$

These intersecting lines may be drawn with less opportunity for error if every other mid-point of the lines connecting each point is plotted with a different color. In this manner, the above intersecting line for any given point would be connecting two points of like color.

2. *The Five-Months Moving Average.* The procedure for plotting the five-months moving average follows exactly that as described for the four-months moving average with one additional step. This average is the point of intersection upon the third ordinate, of the line connecting the mid-point of the intersecting line, as described in the four-months moving average, with the fifth point of the average. In Chart IV_B, R is shown on the third ordinate at the point of intersection of the line $\overline{M_{13}E}$, M_{13} being the mid-point of $\overline{M_1M_3}$, the end points of which are the mid-points of $\overline{AB}$ and $\overline{CD}$ respectively. This is illustrated also in Chart IV and has the mathematical expression

$$R=\frac{4\left(\frac{\frac{A+B}{2}+\frac{C+D}{2}}{2}\right)+E}{5}=\frac{A+B+C+D+E}{5}.$$

3. *The Six-Months Average.* The six-months moving average is merely an extension of the above procedure with the only difference that instead of drawing, as in the five-months average, the line connecting the mid-point M_{13} of the intersecting line, $\overline{M_1M_3}$, with the fifth point, *i. e.* $\overline{M_{13}E}$, it is necessary to draw a line connecting M_{13} with the mid-point of $\overline{EF}$. This line is shown in Chart IV_C as $\overline{M_{13}M_5}$, the intersection of which upon the ordinate half way between the third and fourth locates the six-months average and is designated as R. It will

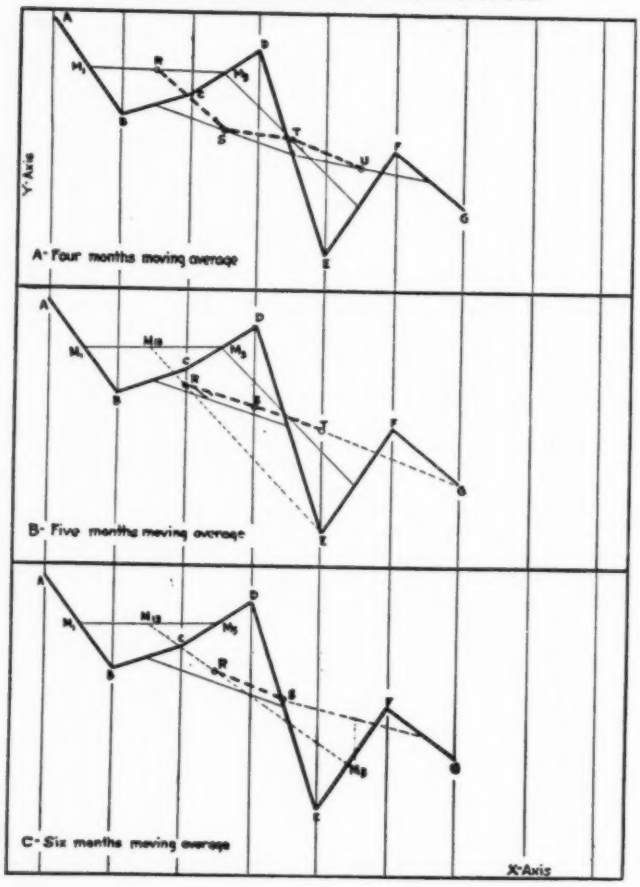
be noted that R trisects the line $\overline{M_{13}M_5}$. The mathematical expression for the graph may be written

$$R=\frac{2\left(\frac{\frac{(A+B)}{2}+\frac{(C+D)}{2}}{2}\right)+\frac{(E+F)}{2}}{3}=\frac{A+B+C+D+E+F}{6}.$$

4. *Averages for periods greater than six months.* The averages for periods greater than six months may easily be constructed by appropriately combining different averages of shorter periods. For in-

CHART IV

GRAPHICAL CONSTRUCTION OF AVERAGE VALUES FOR PERIODS GREATER THAN THREE MONTHS



stance, an eight-months average would be the simple average of the average of two consecutive groups of four points, mathematically expressed as

$$R=\frac{\frac{(A+B+C+D)}{4}+\frac{(E+F+G+H)}{4}}{2}=\frac{A+B+C+D+E+F+G+H}{8}.$$

In a similar manner ten-months and twelve-months moving averages are simple averages of averages for consecutive groups of five or six points, respectively.

The actual process of locating these points of average on the chart may be made in two simple steps. First, it will be necessary to determine the points of average for the shorter periods by methods previously described, and second, to determine their average according to the result desired. An eight-, ten-, and twelve-months average, as has already been suggested, can be derived by dividing the sum of the averages for two consecutive groups of four, five and six months, by two. Graphically this would be the mid-point on a line connecting the respective averages for the consecutive groups of four, five or six months. With practice it will be found that these points may be located very quickly, requiring in actuality few construction lines. Chart V indicates the method used in securing a twelve-months average. X is the average for the first six points and Y is the average for the last six points. The average of these two points, R, is the twelve-months average. It will be noticed that most of the lines need not be drawn, that the points may be spotted along a ruler and the location of the average derived in that manner.

A nine-months average may be located graphically at the point where a line connecting a four-months average with a five-months average crosses the fifth ordinate. This intersecting distance may be seen to be four-ninths the length of the line. It is obviously understood that the four- and five-months averages are for consecutive groups of four and five points respectively. The mathematical expression for these values may be recognized in the following:

$$R=\frac{4\left(\frac{A+B+C+D}{4}\right)+5\left(\frac{E+F+G+H+I}{5}\right)}{9}$$

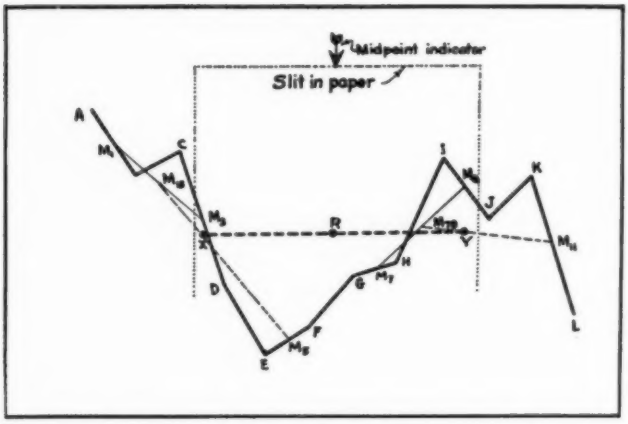
$$=\frac{A+B+C+D+E+F+G+H+I}{9}.$$

From the foregoing discussion, the graphical representation of mov-

ing averages has been shown to be both possible and practical. The simplicity of the method, however, may have been hidden in the light of the mathematical proofs that of necessity accompanied the discussion of the method. Nevertheless, it will be found that with a little practice, as one gradually comes to understand the process, the points of average for any of the mentioned lengths of periods may very easily and quickly be located.

CHART V[1]

CONSTRUCTION OF A TWELVE-MONTHS AVERAGE



[1] Chart V indicates a practical aid for locating the twelve-months average. A twelve-months average is the simple average for two consecutive groups of six months, *i. e.* the first and seventh of the six-months averages. With this in mind, a slit is cut in a piece of paper as shown in the Chart, just wide enough to exclude from sight all but seven of the six-months moving averages. By this aid it will be seen that the mid-point of the line connecting the two end points within the slit, *i. e.* the first and seventh six-months averages, will be the simple average of the two, and will be located on the ordinate half way between the sixth and seventh points, and is the twelve-months average.

NOTES

ILLEGAL ENTRY OF ORIENTALS INTO THE UNITED STATES BETWEEN 1910 AND 1920

By C. Luther Fry

One of the valuable uses of statistics is to find the probable magnitude of data that cannot be precisely measured. The ascertaining of the number of smuggled Orientals is a problem of this type as it is virtually impossible to gather information directly on the subject. The problem, however, can be attacked indirectly. Available data make it possible to estimate the minimum, the maximum, and the most probable number of Orientals who illegally entered the United States between 1910 and 1920.

In other words, it is feasible to approximate the size of a significant social group whose members cannot be counted separately. This procedure is important because there are doubtless many similar problems that could be handled in the same way. For example, it should be possible, by employing in general the same method, to ascertain the number of Mexicans who are illegally entering this country.

An analysis of official figures reveals that during the ten-year period ending in 1920, not fewer than 7,150 Chinamen and 9,400 Japanese entered illegally. As the total number of Oriental males living in the United States in 1910 was only 143,688, a minimum of 16,500 Asiatics who must have been smuggled in, is equivalent to one-eighth of all those in the country. Further analysis shows that there might have been as many as 50,000, but that the actual number who entered illegally was probably about 27,000.

The fact that there has been smuggling has been admitted by no less an authority than the Commissioner of Immigration himself. In the report of January 30, 1919, he declared: "Confidential information of unquestionable authenticity shows very conclusively that Japanese smuggling across the Mexican border is carried on successfully, and doubtless to a very large extent." In the 1925 report the statement is made: "A machine has been built up designed solely to operate against those smuggling Chinese and Japanese." These and similar statements which have appeared with notable frequency in annual reports of the Commissioners, demonstrate beyond question that Orientals are

coming in illegally. The numbers involved, however, have not been known.

The method of arriving at the minimum number of smuggled Asiatics is simple. The Thirteenth and Fourteenth Censuses give the country's total Oriental population for 1910 and 1920 respectively. Statistics of the Commissioner of Immigration show the total number of Chinese and Japanese who legally entered the country during the decade, and figures from the Census Bureau make it possible to arrive at the maximum excess of births over deaths among Orientals in the United States; it therefore becomes easy to find the minimum number who must have entered the country illegally. All that is necessary is to add to the Oriental population of 1910, the number of Orientals who during the next ten years legally entered this country from abroad, and the maximum number who could have been born here, and then to subtract the known losses through emigration and death. The result is the maximum number of Chinese and Japanese that would have been residing in the United States in 1920, provided there had been no smuggling. A comparison of these figures with the 1920 Census totals reveals the minimum number of Chinese and Japanese that must have been smuggled into the country in order to make the 1920 figure as large as it was actually found to be.

Because it is only reasonable to suppose that men are being smuggled rather than women, the two sexes throughout this study have been analyzed separately. The figures appear in the table.

	Chinese		Japanese	
	Male	Female	Male	Female
(A) Total number of Orientals (1910 Census)	66,856	4,675	63,070	9,087
(B) Aliens legitimately arrived, 1910 to 1920 (Immigration Report)	76,080	3,431	64,841	50,865
Immigrant	15,590	2,691	33,131	45,950
Non-immigrant	60,490	740	31,710	4,915
(C) Maximum of children born here since April 15, 1910, and who were alive at 1920 Census date	2,559	2,559	12,871	12,871
(D) (A)+(B)+(C)	145,495	10,665	140,782	72,823
(E) Aliens departed, 1910 to 1920 (Immigration Report)	88,723	1,617	72,841	18,725
Emigrant	20,738	621	11,533	3,068
Non-emigrant	67,985	996	61,308	15,657
(F) Known deaths from 1910 to 1920 of Orientals over ten years (Census Report)	10,048	589	4,661	1,589
(G) (E)+(F)	98,771	2,206	77,502	20,314
(H) Maximum Oriental population, 1920, if there were no smuggling (D)−(G)	46,724	8,459	63,280	52,509
(I) Actual Oriental population, 1920 (Census Report)	53,891	7,748	72,707	38,303
(J) Minimum number smuggled into the United States, 1910 to 1920	7,167	....	9,427	....

The top line of this table shows the total number of Orientals listed in the Census of 1910. To get at the maximum number that could have

been living in the United States in 1920, exclusive of those smuggled, the first step is to add the increase through immigration and through births. Line (B) of the table gives the total number of alien Chinese and Japanese who legally entered the country between July 1, 1910, and January 1, 1920.[1]

Line (C) shows the maximum number of Oriental children born in this country between 1910 and 1920 who could have been alive and living here in 1920. These figures were derived from the 1920 Census. So far as the females are concerned, the numbers given in the table are merely the total of Oriental girls under ten years of age as given in the 1920 Census. Of course, this number tends to overestimate the actual number of girls alive in 1920 that were born in the United States between 1910 and 1920, because it includes children who came to this country from abroad. In computing this minimum estimate, however, no attempt was made to exclude immigrant children from these figures even though it was known that they had already been counted among the incoming aliens.

So far as the boys are concerned, the number alive in 1920 who were born here since 1910 has been assumed to be identically the same as the number of girls. This, too, is a conservative estimate, because there is a well known biological tendency for the number of girl babies born to any given group of mothers slightly to exceed the number of boy babies.[2]

From this analysis it is clear that line (D) of the table represents the maximum number of Orientals that could have been alive in 1920 if there had been no emigration and no deaths of Orientals over ten years of age. But the number of Oriental emigrants between 1910 and 1920 is known. These are the figures given in line (E). Moreover, an incomplete count of the Chinese and Japanese over ten years of age that died during the decade is also available from the mortality statistics compiled by the Federal Government for the registration area.[3]

[1] These figures, which were obtained from regular or special reports of the Commissioner General of Immigration, exclude data for the period April 15, 1910, to July 1, 1910; but it is not believed that this omission is serious, particularly because this exclusion is largely compensated by the fact that the emigration figures given in line (E) also exclude this same two and one-half month period. A special report compiled in the office of the Commissioner General shows that between April 1 and July 1, 1910, the total number of immigrant and non-immigrant Chinese who entered the country was 1,537, while the number departing was 1,527. Although the figures are not available by sex, it seems reasonable to assume that the number of Chinese women and men excluded from this computation because the period April 15 to July 1, 1910, was omitted would be compensated by the fact that numbers departing during this same period were also excluded. For the Japanese, the total number who entered the country between April 1 and July 1, 1910, is known to be 1,242, while the emigrants totaled 1,709. In this case, the arriving aliens were more than compensated by those who departed.

[2] The fact that the Chinese and Japanese boys under the age of ten years, as given in the 1920 Census, outnumber the girls, can easily be explained by a tendency for more boys than girls to enter the country as immigrants.

[3] Because the Government was unable to furnish even for the registration area the exact number of Orientals over ten who died between January 1, 1910, and April 15, 1910, the number of deaths during

If now the total number of Chinese and Japanese who, between 1910 and 1920, legally departed from the United States, or who are known to have died, is subtracted from the maximum number of Orientals given in line (D), the remainder is the maximum Oriental population that could have been living in the United States in 1920 if there had been no smuggling. By comparing these figures with the actual number of Orientals living in the United States in 1920 as given by the Fourteenth Census, it is a simple matter of subtraction to arrive at the minimum number that must have illegally entered during the decade. These figures, which are presented in the last line of the table, show that the number of smuggled Chinese men was at least 7,167, while the number of Japanese must have been no less than 9,427. In other words, the total number of Oriental men smuggled in during the ten years following 1910 could not have been less than 16,594.

Even this figure is undoubtedly smaller than the actual number of those smuggled. In reality, as has already been stated, there may have been as many as 50,000, but the probable number was about 27,000.

It is obvious that the minimum estimate of those smuggled is too low. Between 1910 and 1920 many more Orientals over ten years of age died in the United States than are shown in the computation. The figures employed in the table are merely totals for the registration area which even today covers only a fraction of the United States and was decidedly less in 1910.

Not only does the computation underestimate the number of deaths but it overestimates the number of births, because, as has been previously mentioned, it assumes that all the Oriental girls under ten years of age reported in the 1920 Census (and similar number of boys) were born in this country when in reality some of them were undoubtedly born abroad and have therefore also been counted among the number of incoming aliens.

The extent to which these factors inflate the 1920 estimates can be seen by studying separately the figures for females which are undoubtedly little affected by smuggling. Among both the Japanese and Chinese women the actual 1920 population was decidedly below the estimates. In the case of the relatively few Chinese females the real 1920 figure was nearly 10 per cent below the estimate, while for the Japanese it was almost 30 per cent less.

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this period was assumed to be one-third of the 1910 total. Moreover, it was necessary for the years 1912 and 1913 to estimate the probable number of deaths under ten years; but since the total number of Oriental deaths in the registration area was known, and since the age-distribution of the Chinese and Japanese who died during the other eight years of this decade was also known, these figures could easily be estimated with a high degree of accuracy.

Presumably the 1920 estimates for the males are also inflated to the same extent. On the rather radical assumption that the estimates for the men are 30 per cent too high, the Chinese population in 1920, assuming there had been no smuggling, would become 14,000 less than the figure in the table, while the Japanese figure would be reduced by nearly 19,000. This in turn would increase the number of smuggled Orientals from 16,500 to 49,500. This figure, of course, is almost certainly a maximum. It would seem more reasonable to assume that our 1920 estimates are probably 10 per cent too high in which case the number of smuggled Orientals becomes approximately 27,000.

This study, therefore, tends to prove that the number of Orientals smuggled into the United States between 1910 and 1920 ranged between 16,500 and 50,000 with the probable number around 27,000.

The question of smuggling is likely to become a problem of increasing public importance. It is generally recognized that the passage of the new laws restricting immigration has tended greatly to increase the number of aliens who are entering the country illegally. It is believed that after the appearance of the 1930 Census it will be possible by employing essentially the same method developed in this paper to ascertain not only the number of Orientals who illegally entered during the decade 1920 to 1930 but in addition to find the number of smuggled European aliens.

THE PROBABLE ERROR OF THE STANDARD DEVIATION

By J. Arthur Harris and Marie M. Ness, *University of Minnesota*

Statisticians have long known[1] that the probable error of the standard deviation, σ, is

$$E_\sigma = .6745\sqrt{\frac{\mu_4 - \mu_2^2}{4N\mu_2}} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where μ_4 and μ_2 are respectively the fourth and second moment coefficients of the sample of N individuals about the mean as origin. In the event that the frequency under consideration is of normal distribution, this form reduces to the simpler

$$E_\sigma = .6745\frac{\sigma}{\sqrt{2N}}, \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

which involves only the calculation of the square root of the second moment coefficient.

While Pearl[2] long ago showed that (1) and (2) may give very inconsistent results, the latter is the only formula given in most (but not in all[3]) textbooks, and enjoys almost universal application in practical statistical work.

A comparison of the results of the application of the two expressions to a large number of series of varied frequency distributions should be of interest. It is desirable that the frequency distributions while diverse in form should have as many characteristics in common as possible in order to make the constants comparable. The frequency distributions themselves should be available for reference.

These conditions are met by the entries of Table I, which shows the standard deviations and the probable errors as calculated by the two formulae for number of seedlings per hill (range 0 to 6) in experiments designed to test the capacity of various cotton varieties for the establishment of seedling stand under field conditions. The data are available in full detail elsewhere in papers by Harris, Harrison and Wadley,[4] by Harris and Ness[5] and by Harris, Harrison and Lockwood.[6]

[1] Karl Pearson, "On the Probable Errors of Frequency Constants," *Biometrika*, 2: 273–281, 1903.

[2] R. Pearl, "On Certain Points Concerning the Probable Error of the Standard Deviation," *Biometrika*, 6: 112–117, 1909.

[3] G. Udny Yule, *An Introduction to the Theory of Statistics*, p. 347, 1911; R. A. Fisher, *Statistical Methods for Research Workers*, pp. 74–75, 1925.

[4] J. Arthur Harris, George J. Harrison and F. M. Wadley, "Illustrations of the Application of a Criterion of the Deviation of an Observed from a Random Distribution to the Problem of Seedling Stand in Sea Island, Egyptian and Upland Cotton," *Journal of Agricultural Research*. In press.

[5] J. Arthur Harris, and Marie M. Ness, "The Applicability of Pearson's Equivalent Probability r Method to the Problem of Seedling Mortality in Sea Island, Egyptian and Upland Cotton," *Journal of Agricultural Research*. In press.

[6] J. Arthur Harris, G. J. Harrison and E. K. Lockwood, "A Criterion of the Differentiation of

The differences between the two formulae range from −14.70 to +111.29 per cent of the values given by the general formula (1). It is quite clear, therefore, that in the case of distributions which differ widely from the normal the use of the conventional formula (2) may in some cases lead to large errors of interpretation.

TABLE I

Experiment number and variety	Standard deviation	(1) Probable error by $.6745\sqrt{\frac{\mu_4-(\mu_2)^2}{4N.\mu_2}}$	(2) Probable error by $.6745\frac{\sigma}{\sqrt{2N}}$	Difference (2)-(1)	Percentage difference $100\frac{(2)-(1)}{1}$
Exp. 3/22					
Pima Egyptian	1.939197	.016885	.024373	+.007488	44.35
Meade Upland	1.546277	.020078	.019434	-.000644	3.21
Acala Upland	1.900103	.013480	.022625	+.007165	46.34
Exp. 1/23					
Pima Egyptian	1.734588	.024349	.021802	-.002547	10.46
Lone Star Upland	1.606085	.023686	.020187	-.003479	14.70
Exp. 1/25					
D 1-10					
Pima Egyptian	1.943650	.032865	.048356	+.013490	41.04
Smooth Seeded Pima	2.005717	.035579	.047836	+.012257	34.45
Acala Upland	1.768644	.033719	.042162	+.008464	25.10
Okra-Leaved Acala	1.729408	.031534	.042677	+.011143	35.34
D 2-3					
Pima Egyptian	2.039863	.019901	.036248	+.016347	82.14
Smooth Seeded Pima	2.176145	.023514	.038670	+.015156	64.46
Acala Upland	1.847513	.026162	.032830	+.006668	25.49
Okra-Leaved Acala	1.770349	.028528	.031459	+.002931	10.27
D 1-10 + D 2-3					
Pima Egyptian	2.048011	.017111	.029158	+.012047	70.40
Smooth Seeded Pima	2.120794	.019794	.030223	+.010429	52.69
Acala Upland	1.824521	.020582	.028001	+.008419	26.33
Okra-Leaved Acala	1.800240	.012142	.025655	+.013513	111.29
Exp. 2/26					
Pima, with Meade	1.982826	.036827	.061051	+.024224	63.78
Pima, with Lone Star	2.030288	.030721	.062512	+.025791	70.24
Pima, with Acala	1.882742	.041039	.057970	+.016931	41.26
Pima, with Durango	1.921439	.037992	.059161	+.021469	56.96
Pima Egyptian	1.960760	.018951	.030176	+.011225	59.23
Sea Island, with Meade	2.220325	.034938	.068364	+.033426	95.67
Sea Island, with Lone Star	2.110144	.040258	.064971	+.024713	61.39
Sea Island, with Acala	2.059514	.040834	.063412	+.022578	55.29
Sea Island, with Durango	2.273949	.034062	.070012	+.035950	105.54
Sea Island	2.172187	.018560	.033430	+.014870	80.12
Meade Upland	1.609464	.039980	.052328	+.012348	30.88
Lone Star Upland	1.382027	.036221	.042553	+.006332	17.48
Acala Upland	1.631246	.039604	.050226	+.010622	26.82
Durango Upland	2.155576	.034920	.066370	+.031450	90.06
Exp. 1/26					
Pima, normal irrigation	2.173211	.017544	.022469	+.004925	28.07
Acala, normal irrigation	1.904346	.013498	.019689	+.006191	45.87
Pima, light irrigation	1.454319	.020930	.015036	-.005894	28.16
Acala, light irrigation	1.455240	.013818	.015048	+.001230	8.90

Varieties, or of the Differentiation of Experimental Areas, With Respect to Their Capacity for the Production of Seedling Stand in Sea Island, Egyptian and Upland Cotton." To be published shortly.

WAGE RATES AND PER CAPITA PRODUCTIVITY

The New York Chapter of the American Statistical Association held a dinner meeting at the Aldine Club, Tuesday evening, February 23. The general subject of the meeting was "Wage Rates and Per Capita Physical Productivity" and papers were presented by George Soule of the *New Republic*, R. P. Falkner of the National Industrial Conference Board, Sumner H. Slichter of the Institute of Economics, and by Paul H. Douglas of the University of Chicago. Dr. E. E. Day presided.

Mr. George Soule, the first speaker, dealt with the practical problems of fixing wages with reference to changes in the productivity of labor. He discussed his experience as advisor to the Machinists' Union and indicated the practical difficulties involved in regulating wages so that real earnings keep pace with the increase in per capita output.

Mr. Falkner addressed himself to the problem of determining labor's contribution to the progress of manufacturing industries and labor's reward for its contribution. He stated that the product per worker was 56½ per cent greater in 1925 than in 1897. Comparisons made between wages paid in manufacturing industries with either value of product or value added by manufacture indicated, he believed, only slight variations in the proportionate share that goes to wage earners. It was his opinion that the chief source of the increased product per worker is to be found in improved equipment processes and organization of industry. If this is so, the share of labor should diminish. He found, on the contrary, that it has remained constant and consequently concluded that the wage earner has shared fully in the recent progress of industry.

The secret of post-war high wages in the United States was the subject of Mr. Slichter's paper. He believed that wages in this country fell between 20 and 25 per cent from 1920 to 1922, but that in view of the great drop in prices and of production they would ordinarily have dropped even more. The fear of labor trouble and the depressed financial condition of employers were responsible for the rigidity of manufacturing wage rates. The rise of wages in 1923 was due to a short business boom in the early months of that year. In the piece work industries, wage rates are lower than they were in 1923; time rates, however, have stayed up. The maintenance of time rates Mr. Slichter attributed to the rise in cost of living, to the upward movement of wages in the building trades and railroads and to the changing labor policy of employers designed to insure the good will of their employees. The ability of employers to pay the prevailing high wages Mr. Slichter ascribes in part to savings in the cost of materials and in part to increased per capita output. This increased output, however, is not due, he believes, either to the use of relatively more power or of more capital but in small part to the concentration of manufacturing in larger units and more particularly to great advances in the efficiency of management and of labor.

Mr. Douglas discussed the whole question of measuring the relation between changes in output and real earnings, and first modified the prevailing measures by including in the category of workers salaried employees as well as wage earners, on

the ground that they contribute to the size of the production of industry. He then pointed out that a more valid comparison was not between physical output and real earnings but between value product and real earnings, and explained the method whereby he derives for industry as a whole and for sub-divisions of industry indexes of per capita value product. By then comparing his new indexes with that of real earnings he comes to two conclusions. First, "that it was not until 1921 that the workers in manufacturing industries produced on the average more purchasing power than in 1899" and second, "when the real earnings of the employees are compared with the average amount of value produced in the respective years, it is seen that instead of real earnings lagging constantly behind, they rose up to 1919 very much more rapidly."

The discussion was led by Mr. Leo Wolman. An analysis of the relation between wages paid and value added by manufacture, he said, would lead to conclusions quite different from those drawn by Mr. Falkner. From 1921 to 1925, for example, the ratio of wages to value added fell from 44.8 per cent to 40.07 per cent, a drop of roughly one-ninth. This drop was to be expected in view of the great increase in per capita output and the attendant cutting of manufacturing cost. The central problem involved in comparing physical value with real earnings lies in the difficulty of obtaining satisfactory figures for the number of people on the payroll, since the number reported on the payroll does not vary with the amount of work done. Mr. Henry S. Dennison held also that quite a different face might be put on the per capita output figures if statistics of the number of workers employed were replaced with statistics of total hours worked. The discussion was ended by Mr. John R. Commons, who missed in the papers of the evening consideration of the social implications of these statistical inquiries. From a social standpoint, he said, the crucial factor was the number of persons unemployed and no comparisons that did not take their numbers into consideration can claim to be regarded as telling the most important part of the story.

L. W.

THE COTTON CROP AND ITS PRICE

A Dinner Meeting of the American Statistical Association was held on Friday evening, April 20, 1928, at the Aldine Club, 200 Fifth Avenue, New York City, attended by about 125 persons. Mr. Gardiner H. Miller, Vice-President of the New York Cotton Exchange, presided.

The first speaker was Mr. W. F. Callander, Chief, Crop Reporting Board, United States Department of Agriculture. He stated that cotton was one of the first crops for which the Government began to issue crop reports, but that it was not until 1915 that forecasts of the crop were issued prior to harvest. "No other reports of the Department have been so severely criticized, although for no crop has the Department spent as much money or worked as hard to get the facts." He stated that much of this criticism has been due to misunderstanding of the character of the reports, which in reality have not been forecasts but have been based on the assumption that subsequent conditions would be average. Mr. Callander divided the problem connected with the reporting of the crop into two

classes, those having to do with acreage and those having to do with forecasting of the yield per acre.

Until a few years ago estimates of acreage were based very largely upon judgment inquiries and personal observation, but these judgment inquiries often led to error, particularly in years when there was extensive propaganda to reduce acreage, and since that time the Board has endeavored to develop other methods less subject to bias.

About ten years ago a system of reports from thousands of individuals was started. This at first led to underestimate of acreage, but experience has shown that there was a rather constant bias for which allowance is now made. Other refinements have also been used. Further light on the acreage problem is afforded by sales of fertilizer, there being a close correlation between fertilizer sales and acreage, particularly in the southeastern cotton states.

The principal innovation of recent years, however, has been the invention of the crop meter, by means of which the linear feet of various crops may be measured on one or both sides of the road on selected routes. Later trips over the same routes give a valuable measure on abandonment.

The Board is now endeavoring to secure authority and funds from Congress to make a partial census of every county in the cotton belt each year, and has made studies which show that a farm to farm canvass of from 8 to 10 per cent of the total acreage in each county would afford a reliable sampling. The state of Alabama has already made an annual appropriation for such acreage surveys.

In regard to the estimation of the yield per acre, Mr. Callander stated that the boll weevil had necessitated modifications in previous methods. Various means have been devised to determine the proper allowance for possible damage from this source, a study having shown that the boll weevil was not only the dominating factor causing variation in yields per acre but also that there was a tendency for the damage to run in cycles. Other indications of probable production are afforded in boll counts, stand and size of bolls.

Mr. Callander concluded by stating that the Crop Reporting Board is constantly working out further improvements and is exerting every effort to improve the value of the service.

The second speaker was Mr. E. C. Morse of the Cotton-Textile Institute, who, after giving some figures indicating the magnitude and importance of the cotton industry described the organization and aims of the Institute. Its activities fall into three principal groups—Cost Accounting, Statistical, and New Uses. The New Uses section is not confined to work indicated by its name, but also has general supervision over research, specifications, simplified practice, standardization and test methods.

Mr. Morse described some of the New Uses which have been developed such as the use of cotton fabrics in traffic control and paving, and described the methods that are being followed to increase consumption of cotton for use in bagging, belting, clothing and the like.

The third speaker was Mr. L. H. Bean, Agricultural Economist, United States Department of Agriculture, who spoke on certain inter-relationships between the supply, price and consumption of cotton and described how it had been possible

by taking certain series of data representing supply and demand to determine not only the average effect of a change in any one of these factors on the price of cotton but also that the factors selected are those which usually determine the price, and in the aggregate explain about 90 per cent of the total variations occurring in the period from 1905 to 1926.

Mr. Bean divided the findings of his studies into two groups—(1) those which show that supply affects price and (2) those which show that price affects supply, and summarized his paper as follows:

> *Supply affects price:* The total supply (crop and carryover) which is usually known at the beginning of the season very largely determines the average level of prices for the year. The size of the crop and the probabilities as to the size of the following crop determine the major monthly movements during the course of the crop season.
>
> *Price also affects supply:* Price is a very important element in the following year's acreage. It influences yield in the following year through the amount of fertilizer bought by farmers, and it affects the rate of consumption and the amount of the world carryover at the end of the season.
>
> *Consumption affects price:* Large volumes of cotton and cotton goods in channels of consumption secured at low prices act as a depressing factor, and low volumes as a stimulating factor on subsequent cotton prices.
>
> *Price also affects consumption:* Low prices during the course of a season result in increased mill purchases and in a higher domestic and world mill consumption of cotton. High prices have the reverse effect. In the United States low prices during a given period of six months are followed by increased mill consumption of cotton and high prices are followed by a reduction during the following six months.

The fourth speaker was Mr. C. T. Revere, of Munds and Winslow, Members New York Cotton Exchange. Mr. Revere, after indulging in some early reminiscences in a humorous vein, described the influence of organized Exchanges on the price of cotton, but thought that this was a subject which would probably lend itself better to psychological rather than statistical analysis. "Cotton research is the paradise of the mathematician, but when all is said and done, the ultimate reaction is psychology," and "in the long run, economic forces determine values, but in the meantime emotion makes the market."

Mr. Revere dwelt on the need of organized speculation as a risk-bearer or as insurance against price changes, and likened the criticism of the Exchanges for not preventing violent price swings to criticism of fire insurance for not preventing a building from burning down. His conclusion based on more than twenty years' observation was that the market pays more attention to future policies than past history. "Organized speculation is never interested in water that has gone over the dam, but it is able to see a flood coming down the Mississippi long before the high water has reached Keokuk, Iowa."

Mr. Revere maintained that fluctuations in price would be much more violent without organized trading because of its tendency to discount the future. It "exercises a prophetic function that constitutes one of its most valuable services" and it "pays the highest premium on foresight, for in the solution of its problems, speculative vision is more powerful than a dozen admitted facts."

The discussion that followed consisted of a critical review of the four papers by Mr. A. W. Zelomek, of the Fairchild Textile Service, and a discussion by Mr. K. W. Jappe, of the Brookmire Economic Service, of a portion of Mr. Bean's paper,

in which it was pointed out that a study of the relationship of cotton to the level of all commodities gave some valuable indications of sound buying levels in the price of cotton.

In the discussion from the floor, the questions raised were concerned principally with Mr. Callander's paper and covered mainly the determination of the "pars" and the value of such items as the boll weevil cycle, boll counts and the like as a basis for estimating the crop.

K. W. J.

THE ANALYSIS OF DATA AMONG BUSINESS ORGANIZATIONS

The Sixth Dinner Meeting of the San Francisco Chapter was held on Friday evening, February 17, 1928, at the Bellevue Hotel in San Francisco. Thirty-eight members and guests were present.

The topic for discussion was "The Analysis of Data Among Business Organizations." President Mowbray introduced the speakers of the evening.

The first speaker was Mr. G. C. Bishop of the Statistical Department, The Pacific Telephone and Telegraph Company. His remarks were as follows:

One function of the Statistical Department is the making of estimates of certain accounts for the ensuing year by months and it is in connection with this work that we have found one general method of analysis most satisfactory.

The data analyzed are, in most cases, only available over short periods, or if more ample, display marked changes in the rate of growth. In addition, there are changes resulting from frequent improvements in the art of communication which make it difficult to obtain comparable series for any length of time.

From the standpoint of efficiency, it is desirable to have the personnel thoroughly familiar with some general method of analysis which is applicable in the majority of cases to the data available and which requires the minimum amount of labor and time necessary to obtain satisfactory results.

In the case of the seasonal index, the link-relative method has been found most satisfactory. It permits the use of the entire data; makes sufficient allowance for the distortion due to the presence of the cycle; and admits of an index being obtained without a trend line, the calculation of which is sometimes difficult owing to the short period available or because it is necessary first to correct for seasonal variation in order to determine the best period on which to base a trend. This method is less laborious than any based on moving averages, but is more so than those based on percentages to trend or percentages to annual average. The latter methods, however, have disadvantages which are indicated above.

For trends the less flexible curves have proven most satisfactory, probably due to the short periods used.

It is not intended to convey the impression that the method indicated is advisable or necessary in all cases, for shorter methods may be used frequently, and at times, when analyzing certain types of data, the link-relative method cannot be used. But for a general method which is applicable in most cases, the foregoing has been found satisfactory from all angles.

The second speaker was Mr. Donald S. Thompson of the Division of Analysis and Research, Federal Reserve Bank of San Francisco.

Mr. Thompson emphasized the great need for accurate and dependable data, and stated the problems of the Bank to be: (1) collection of data, (2) determination of representativeness or reliability of the sample, (3) analysis of data, (4) presentation of results, and (5) recommendation for action.

Mr. Thompson's remarks were confined chiefly to a discussion as to the best methods to use for determining the representativeness or reliability of the sample. He illustrated his experience by citing the retail trade series of data gathered by the bank.

It was thought best to use department store sales because of the convenience of approach, and the wide variety of goods handled by the stores assured the best chances for obtaining a representative sample of retail trade. Data were secured from all stores which would coöperate, in each city. A list of names of reporting stores was sent to each store with a request for an estimate of the percentages of sales which reporting stores made to the total department store sales of that city. The estimates conformed closely, with a maximum difference of 15 per cent. The smallest sample was found to be 75 per cent of the total city's sales and the class of stores was so constituted that their goods appealed to every class in the community.

Using this as a basis the total sales for 1920 were estimated by cities and the percentage which each city bore to the total of the cities was compared with the ratio of population of the same cities to their total. It was thought that if the sample were adequate the percentage distribution of sales and population should be the same. The maximum discrepancy was 4.2 per cent and occurred in Los Angeles where sales were greater than population.

Problems of measuring wholesale trade were more difficult and reliance had to be placed on performance tests and judgments of men in the trade, who follow the reports closely.

Many figures on industrial activity are derived from secondary sources, but data are not accepted without question. Lumber production may be taken as an example. Two sets of data are available—one published in the *Survey of Current Business* and the other in the *National Lumber Trade Barometer*. Seasonally adjusted indexes were prepared from both series. The Bureau of the Census publishes annual data showing lumber cut by states. The monthly data totals for the year agree poorly with the annual totals of the Census, but it was found that an arithmetic average of the annual indexes of the two series agreed very closely with the Census data. Accordingly an arithmetic average was taken of the two seasonally corrected monthly series. This was used with certain adjustments for discrepancies in data during the first six months of 1927.

Most data were reduced to a daily average basis before analysis. Trends where used at all were confined to simple curves due to difficulty in projecting complex curves. Little use is made of correlation or regression formulae, except for office studies.

The last speaker was Dr. W. L. Crum of the Graduate School of Business, Stanford University, who cited many examples of statistical analysis in different lines of endeavor.

Dr. Crum observed that the cost of statistical analysis was often out of propor-

tion to the results attained, or the accuracy secured. The statistician takes the raw material and turns it into a fabricated product—recommendations for action. Simple analyses are desirable, because the ultimate consumers are not statisticians and understand only simple analyses. The best methods are usually inexpensive and simple.

In presenting agricultural data, mapping has been overdone. It does not show differences in magnitude although it is adapted to showing qualitative differences. Bar charts are more effective for showing yield per acre, acreage, etc. Mapping is better adapted to showing costs of transportation, production, and differences of a qualitative nature. The recording of a variable changing with time is shown by the Gantt chart better than by the histogram.

The interpretation of a statistical result is important. In agriculture shall we study the decline of dollar purchasing power or the purchasing power of the product of the farmer? The aim in this and future questions is not to state the best method but to emphasize the divergence of the methods possible to be used.

It was desired to study the output of a wire plant. Details of output were not available, due to changes in products. This might be approached through a deflation of sales by an appropriate price index, which was not entirely satisfactory; or through sampling (280 products). The mathematical theory of statistics was developed in connection with random sampling, or selection by chance. The samples used would be selected by design and the probable error formulae would not be satisfactory.

A locomotive company wished to forecast its locomotive sales. It might analyze past sales and project, or analyze economic factors affecting the demand for locomotives. The former showed an increase while the latter did not.

In non-time series it was necessary to determine a measure of machine utilization. The machines were of different types used in different processes in various plants. The indexes would have to combine individual machine indexes into department indexes and then combine these by plants. They might be weighted by (1) value of machine; (2) physical volume of production; (3) square feet of floor space occupied; (4) power used by the machine; (5) number of employees; or (6) amount of payroll. As some of these weights correlated with utilization, careful selection of weights was particularly desirable.

In measuring the freight traffic originating in a large economic area, the economist is interested in the number of car loads, or how much business is delivered to the railroads, while the railway statistician is interested in the number of ton miles, or the probable revenues of the road. In appraising the sufficiency of maintenance of a railroad, the investor usually deals in terms of percentage of gross revenues while the railway statistician might deal in terms of traffic density; train or ton miles.

Determination of an operating standard can be done from internal records, or the study of a large number of similar businesses. It is cross section versus historical analysis.

In appraising the advertising value of a particular medium serving a territory we may take lineage, or circulation; or perhaps lineage and revenues.

In removing seasonal, there is usually a presumption against a shifting sea-

sonal. A changing seasonal concept may be due to major cyclical causes; and an unvarying seasonal is to be preferred.

During the discussion which followed, President Mowbray discussed problems of rate making for workmen's compensation insurance, and George M. Eberhard pointed out the dangers of too general an analysis of conditions, which has no value to a business man due to difficulty in applying it to his own business. He asked for statistical analysis which was more applicable to the every-day problems and management of the business.

The meeting adjourned.

R. W. B.

SOCIAL SCIENCE ABSTRACTS

The Social Science Research Council announces plans to establish a *Journal of Abstracts in the Social Sciences*. These plans are the result of five years' study by a committee of the Council which has canvassed the situation with respect to the needs, resources, and purposes to be served by a comprehensive abstract service in the social sciences.

A substantial subsidy has been provided for a period of ten years until the *Journal* has become self-supporting through subscriptions.

In its report to the Council at Hanover, New Hampshire, in August, 1927, the Committee on Social Science Abstracts stated the need for abstracts in the following paragraphs:

> The founding of the Social Science Research Council is itself a recognition of the fact that leaders in the social sciences are convinced that research in these disciplines is greatly in need of stimulation and direction, and farther, that the scholars in these fields should be brought closer together for the consideration and solution of common problems. On the other hand, the deliberations of the Committee on Social Science Abstracts, and much of the information gathered by it, clearly bring out the fact that one great obstacle to the doing of truly scientific research in these fields lies in the tremendous mass of the materials to be considered and in the relative, if not quite complete, lack of appropriate tools for attacking it. There are so many books, pamphlets and reports constantly being published and so many periodicals both scientific and semi-scientific steadily pouring from printing houses both here and abroad, that it is physically impossible for any one to keep abreast of all the literature even in his own special field of work. For this reason also, and in making a courageous effort to read what he should, he is likely to take first the publications obviously in his own special field, and for lack of time to do more, to become increasingly oblivious of what is being done in other disciplines upon the same subjects. Thus artificial departmental lines tend to become sharper, and in his mind the social sciences stand as distinct and separate fields.
>
> To overcome these difficulties, a journal is proposed which will save an almost infinite amount of time and labor on the part of research workers, by giving them in one journal complete citations and short but objective abstracts of all important new materials, and will at the same time draw together the several disciplines by serving them all through one journal based upon some systematic classification and improved by numerous cross-references to the materials in other fields. Other important advantages of such a publication could easily be stated. It will save much duplication and waste of effort, it will apprise the worker of the existence of other specialists working on his problems and stimulate correspondence between them, it will call attention to new methods of research, it will serve as a permanent record of the work already accomplished, and will in many other ways promote the healthy development of the sciences to which it relates.

The Social Science Research Council has appointed a Committee on Social Science Abstracts consisting of the following scholars, and charged with the responsibility of organizing and establishing *Social Science Abstracts:* Dr. Isaiah Bowman, American Geographical Society, chairman; Dr. Davis R. Dewey, Editor of the *American Economic Review;* Dr. Carlton J. H. Hayes, Professor of History, Columbia University; Dr. Frederic A. Ogg, Editor of the *American Political Science Review;* Dr. Frank A. Ross, Editor of the *Journal of the American Statistical Association;* Dr. Clark Wissler, Professor of Anthropology, Yale University; Dr. Ellsworth Faris, Editor of the *American Journal of Sociology;* Dr. F. Stuart Chapin, Professor of Sociology, University of Minnesota, has been appointed as editor for the year. To assist the Organizing Committee, a number of advisory committees have been appointed in the fields of cultural anthropology, economics, history, human geography, political science, sociology, and statistics.

Social Science Abstracts will be issued monthly during the year and in each issue will appear systematic abstracts of new information published in the fields indicated for the preceding month or months. *Social Science Abstracts* will be printed in English in this country, but it will attempt to cover the social science literature of the world as originally published in all languages.

Negotiations are under way to establish a satisfactory basis of coöperation with the Committee on Intellectual Coöperation of the League of Nations, in working out a modus operandi with the arrangements for economic abstracts undertaken by this international organization.

The test of published materials to be abstracted will in general be the criterion of *new information,* in the sense of important factual studies and contributions to theory and opinion, in the fields of the social sciences indicated. This will require the careful scrutiny of articles in periodicals, pamphlets, bulletins, monographs, and new books. It is conservatively estimated that the annual number of abstracts will run to fifteen or twenty thousand titles the first year. The abstracts will be cross-referenced and annual indexes published. It is hoped that the first number of *Social Science Abstracts* will be published at the beginning of the next calendar year.

F. Stuart Chapin, *Editor.*

PROGRESS OF WORK IN THE CENSUS BUREAU

CONFERENCE ON CURRENT BUSINESS STATISTICS

The American Paper and Pulp Association recently circularized economists and others interested in securing better index numbers on business conditions, with a view to obtaining more current statistics through the Department of Commerce. As a result of the general approval of this suggestion, a small group met informally under the auspices of the Department of Commerce at its New York office on February 17 to discuss what statistics are most needed at the present time to fill up the gaps in the available current information.

This committee recommended that statistics of stocks, in the hands of both

manufacturers and dealers, were the most urgent at the present time. A number of important commodities were tentatively listed as desirable for such additional data, including basic steel products, automobiles, electrical products, lumber, textiles, paper, shoes, chemicals, coke, copper, agricultural implements, etc., for some of which manufacturers' stocks are already available. The matter of securing such statistics is being taken up with trade associations and others in the industries concerned. In many cases, such information cannot be supplied at the present time, but certain of the recommendations can probably be secured in the near future.

The following were present at the meeting: W. L. Chandler, Secretary, National Association of Purchasing Agents; Dr. Lewis H. Haney, Director, Bureau of Business Research, New York University; P. S. Hanway, Manager, American Waxed Paper Association; Virgil Jordan, Economist, National Industrial Conference Board; E. W. McCullough, Manager, Department of Manufacture, Chamber of Commerce of the United States; and Ray Vance, President, Associated Consulting Economists.

The Department of Commerce was represented by Mortimer B. Lane, Editor of the *Survey of Current Business*, Bureau of the Census, and by Mr. Eichelberger, Assistant to the New York District Manager, Bureau of Foreign and Domestic Commerce.

RECORD BOOK OF BUSINESS STATISTICS

Part II of the *Record Book of Business Statistics*, covering metals and machinery, was issued in March. This volume consists of sixty pages presenting monthly and quarterly statistics from 1909 through 1926, where available, on production, stocks, shipments, new orders and unfilled orders, exports and prices on the various metals and their products, including machinery. The data in the *Record Book* form a background for the current data presented in the *Survey of Current Business*. Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at ten cents each. Part I, covering textiles, may also be obtained at the same price. Part III, covering fuels, automobiles, and rubber, is almost ready to be printed.

CURRENT WAREHOUSE STATISTICS

Beginning with the January report, monthly statistics on merchandise warehousing were inaugurated by the Bureau of the Census, after a canvass of the industry conducted by the American Warehousemen's Association. These statistics, which are given by states and which it is planned to segregate later by cities for which all warehouses report, comprise area of space owned, leased and occupied, and tonnage received. It is believed that these figures will not only show warehousemen the condition of their industry for the first time, but will also be valuable in indicating trends in distribution.

CENSUS OF ELECTRICAL INDUSTRIES

The Bureau is now engaged in conducting the quinquennial census of electrical industries relating to the year 1927. The census covers Central Electric Light

and Power Stations, Electric Railways, Telephones, and Telegraphs. The canvass is carried on in connection with the biennial census of manufactures covering the same year. A special effort is being made to obtain statistics, as nearly complete as possible, in regard to the power-plant equipment and output of electric current by all classes of establishments which operate electric generators of 100-kilowatt capacity or more. The manufactures census and the censuses of electric light and power stations and electric railways together will account for most of the important power plants in the country, but a special canvass of the so-called "isolated plants"—*i. e.*, electric power plants operated by mines, hotels, theatres, amusement parks, etc.—is also being made.

FARM MORTGAGE DEBT

A study of farm mortgage indebtedness, 1925, on farms operated by tenants and managers in representative counties of the United States is now in progress. The study is made jointly with the Department of Agriculture, and, in addition to furnishing certain information regarding mortgages on the particular farms tabulated will also furnish data for use as a basis in estimating the total mortgage debt of these classes of farms. This estimate, added to the data for owner-operated farms obtained at the 1925 census, will provide a fairly accurate estimate of all farm mortgage debt, comparable with the estimate made following the 1920 census.

TOWNSHIP STATISTICS OF AGRICULTURE

There is an increasing demand for township statistics of the census of agriculture, indicating the present-day need for farm statistics for a smaller unit than the county. Many requests for township figures have been received, and the Bureau has furnished more than 50 estimates of the cost of making such tabulations. In most cases, however, the cost has been too great, and the Bureau has, in fact, made only 12 such tabulations from the 1925 census. In these cases the states or organizations have paid for the additional clerk hire, etc. The tabulations ranged in scope from the number of farms by townships in a single county to practically all items of the census by townships for an entire state. In addition, a number of township tabulations have been made by employees paid by the Department of Agriculture.

J. A. H.

INTERNATIONAL POPULATION UNION

At the last session of the World Population Conference in Geneva, on September 3, 1927, there were passed the following resolutions:

> The World Population Conference resolves that a permanent international organization be created for the object of studying population problems in a strictly scientific spirit.
>
> A Provisional Committee is hereby authorized to prepare the constitution for this organization.

In accordance with these resolutions the following Provisional Committee for the organization of an International Union for the Scientific Investigation of

Population Problems was then appointed, with power to coöpt additional members until the total number of the Committee was fifteen:

	Representing
Sir Bernard Mallet Professor F. A. E. Crew	United Kingdom of Great Britain
Professor E. M. East Professor Raymond Pearl	United States of America
Professor Leon Bernard	France
Professor Erwin Baur	Germany
Professor Corrado Gini	Italy
Professor W. Rappard	Switzerland
Professor A. Mahaim	Belgium

Under the power granted for coöptation the following persons have been added to complete the Committee:

	Representing
Professor Severino Aznar	Spain
Professor Kiyo Sue Inui	Japan
Professor H. Lundborg	Scandinavia
Professor J. H. dePaula Souza	South America
Doctor Charles H. Wickens	British Dominions
Professor V. Bunak	Russia

The Committee organized at Geneva, and appointed Raymond Pearl chairman, and Professor F. A. E. Crew secretary.

Since last September this Committee has been actively engaged in the preliminary work of the organization of the Union, with the financial and moral aid and support of the National Research Council and the Social Science Research Council, acting in coöperation. A provisional draft of the statutes of the Union is now in process of revision. The general plan of organization proposed is closely similar to that of other existing International Unions in the pure and applied sciences, with such differences only as are necessitated by the manifold and wide-ranging character of population problems. The basis of the Union will lie in National Committees in the various adhering countries, these underlying national organizations being composed of scientific men interested and active in research regarding various aspects of population. Such National Committees have already been formed for Great Britain, France, Italy, and the United States, and are in process of organization at the present time in a number of other countries. In the case of the United States committees on population have been appointed by the National Research Council and the Social Science Research Council respectively, which bodies, acting conjointly, will be the official adherents to the Union for this country.

The Provisional Committee will meet in Paris on July 2, 1928, for the purpose of finally completing the preliminary organization of the Union, the first General Assembly of which will take place in Paris on July 4–6, 1928. According to the plan of organization provided for in the statutes, membership in the General Assembly of the Union will be restricted to delegates officially elected by the Na-

tional Committee of the adhering countries. In addition to the members a limited number of persons may be invited by the General Assembly itself to attend its sessions.

The objects of the International Union will be purely scientific. Propaganda of any sort, for any purposes whatsoever, will have no place in its activities.

The purpose of the Union will be to develop scientific studies pertaining to the problems of population, and particularly:

(a) To initiate and organize researches which depend upon international coöperation, and to provide for their scientific discussion and publication.

(b) To facilitate the establishment of common standards for the collection, tabulation and analysis of data regarding human populations, including economic, sociologic, demographic, agricultural, and biologic data.

(c) To serve as a clearing house for the interchange and dissemination of information about population, especially for the purpose of facilitating research.

(d) To coöperate to the fullest extent with other scientific bodies having similar objects.

RAYMOND PEARL, *Chairman of Provisional Committee*

ACTIVITIES OF THE SOCIAL SCIENCE RESEARCH COUNCIL

The annual meeting of the Social Science Research Council took place in Chicago on April 7. A number of important matters were considered.

An increased sum of money has been made available for Grants-in-Aid. At the April meeting $9,600 was allocated to eight individuals. These Grants, unlike the Council's Fellowships, are not awarded merely once a year but are available throughout the year. The next meeting of the Council's Committee on Grants-in-Aid is scheduled for the middle of June.

The following statement sets forth the aim, scope, and conditions governing the awarding of the Council's Grants-in-Aid. The primary interest of the Advisory Committee on Grants-in-Aid is to bring about the completion of a piece of research, rather than the development of promising researchers. Preference will be given to proposals which involve improvement of technique and development of methods; which involve two or more of the social sciences, including history; and which relate to problems of present scientific significance.

Ordinarily Grants-in-Aid will not be proposed by this Committee for persons who are eligible to receive a Fellowship from the Social Science Research Council. Grants-in-Aid will ordinarily be proposed only (a) when a substantial amount of work has already been done; (b) when the need for financial assistance is demonstrated; and (c) when a definite plan for future work has been presented. The Committee will usually expect applicants to indicate a reasonably definite time of completion and prospect of publication of their work.

The Committee has agreed upon the following rules: Applications may be submitted at any time and will be considered at the next meeting of the Committee.

Each applicant shall submit: (a) A careful statement of the proposed plan of work, with submission of parts completed, together with a statement of the ultimate scope and object of the study; (b) a statement of the sum of money desired; (c) the date when he expects to be free to continue his work; (d) the probable date of completion; (e) his professional record, including men under whom he has worked, and their endorsement of his application; (f) a record of other prior or pending applications for aid from this or other agencies.

The launching of a series of Research Fellowships in Agricultural Economics and Rural Sociology for the five-year period 1928–33 is announced. A special committee of the Council has been constituted to handle these Fellowships and consists of the following: Dr. E. G. Nourse (chairman), Dr. Joseph S. Davis, Professor Frank A. Fetter, Dr. C. J. Galpin, Dr. W. J. Spillman, and Mr. Henry A. Wallace.

These Fellowships should not be confused with the Research Fellowships in the Social Sciences which are now in their fourth year.

Twenty-one Research Fellows in the Social Sciences have been appointed for the year 1928–29. Fourteen universities, from Oregon to Harvard, are represented by the Fellows selected, who will gather their material from all parts of the globe. A geographer will study rural communities in Japan; an anthropologist will investigate the problem of adolescent and child psychology in a South Sea island; another the adjustment of individuals to society in a Pueblo village; a third anthropologist the background of Chicago immigrants in Sicily; a political scientist will study the problem of contemporary political leadership in the light of psychiatry and psychology; a psychologist is going to England and the Continent to study current work in the psychology of industry with particular reference to industrial morale.

These Fellowships are granted to young American investigators, both men and women, of outstanding promise in the social sciences. All are under thirty-five years of age and have received the doctor's degree.

Applications for all Fellowships and Grants-in-Aid should be sent to the office of the Council, 50 East 42 Street, New York City.

WESLEY C. MITCHELL

INDEXES OF PRODUCTION OF AGRICULTURAL PRODUCTS

TWELFTH FEDERAL RESERVE DISTRICT

The Division of Analysis and Research of the Federal Reserve Bank of San Francisco is constructing annual indexes of production of agricultural products in the Twelfth Federal Reserve District as a whole and for each state in the district. These indexes are to be segregated into groups as follows: (1) field crops, (2) fruits, (3) grains, (4) vegetables, (5) livestock, and (6) livestock products. Composite indexes of the first four groups and group indexes for each of those groups have been constructed for the district and for each state, covering the years 1923 to 1927, inclusive. Indexes for the livestock and livestock products groups and for those two groups combined, as well as composite indexes for all six groups, are being constructed.

The indexes of physical volume of crop production are weighted aggregates of the volume of crops produced in each state of the Twelfth District expressed as percentages of their 1925–27 average, that is, the 1925–27 annual average equals 100. The weights used are based upon the 1925–27 average value of crops produced in each state as reported by the United States Department of Agriculture. The indexes were constructed as follows:

1. The physical volume of each crop in each state was multiplied by its weight. The weights were obtained by dividing the 1925–27 average value of each crop produced in each state by the average volume of production for those same years of each respective crop in each respective state.[1] In effect, therefore, the weights are 1925–1927 average prices. This process converted all the volume figures into values at unchanging prices and made it possible to obtain for the different years comparable aggregates varying in accordance with changes in the volume of the components, the prices remaining constant.

2. The resulting figures were then totaled for the various crops and states desired and for all crops and states combined.

3. These totals or aggregates were then expressed as percentages of their respective 1925–27 averages, which percentages constitute the indexes.

The relative importance of the different states included in the composite indexes of crop production is given in the following table:

State	*Per Cent*
Arizona	3.7
Nevada	1.1
California	53.6
Oregon	9.3
Washington	16.2
Idaho	11.8
Utah	4.3

Data for the completed indexes of crop production were obtained from *Yearbooks, Crops and Markets*, and state crop reports of the United States Department of Agriculture. Crops used in the indexes follow:

Arizona

Vegetables—Cantaloupes, lettuce, peas (table).
Fruits—Apples (commercial crop), peaches, pears.
Grains—Barley, corn, grain sorghum, oats, wheat.
Field Crops—Beans (dry), cotton, hay (tame and wild), potatoes (sweet), potatoes (white).

Nevada

Vegetables—Cantaloupes.
Fruits—Apples (commercial crop), grapes, peaches, pears.
Grains—Barley, corn, oats, wheat.
Field Crops—Hay (tame and wild), potatoes.

[1] This procedure is similar to that followed by the Federal Reserve Board in constructing an index of industrial production in the United States described in the March, 1927, issue of the *Federal Reserve Bulletin*, page 170, "The New Index of Industrial Production," see especially reference to derivation of weights for minerals, page 173. See also Woodlief Thomas, "Construction of an Index Number of Production," this JOURNAL, p. 315, September, 1927.

California

Vegetables—Asparagus (canning), asparagus (table), artichokes, cabbage, cantaloupes, carrots, cauliflower, celery, cucumbers, lettuce, onions, peas (canning), peas (table), tomatoes (table), tomatoes (canning), spinach (canning), spinach (table), watermelons, all other vegetables.

Fruits—Apples (commercial crop), almonds, apricots, cherries, figs, grapes, grapefruit, lemons, olives, oranges, peaches, pears, plums, prunes, raisins, strawberries, walnuts.

Grains—Barley, corn, grain sorghum, oats, wheat.

Field Crops—Alfalfa seed, beans (dry), cotton, cottonseed, hay (tame), hay (wild), hops, potatoes (sweet), potatoes (white), rice, sugar beets.

Oregon

Vegetables—Cabbage, cauliflower, celery, lettuce, onions.

Fruits—Apples (commercial crop), peaches, pears, prunes (dried).

Grains—Barley, corn, oats, rye, wheat.

Field Crops—Clover seed, hay (tame), hay (wild), hops, potatoes.

Utah

Vegetables—Beans (snap-canning), onions, peas (canning), tomatoes (canning), tomatoes (table).

Fruits—Apples (commercial crop), grapes, peaches, pears, strawberries.

Grains—Barley, corn, oats, rye, wheat.

Field Crops—Hay (tame), hay (wild), potatoes, sugar beets.

Idaho

Vegetables—Lettuce, onions, peas (canning).

Fruits—Apples (commercial crop), peaches, pears, prunes (fresh).

Grains—Barley, corn, oats, rye, wheat.

Field Crops—Alfalfa seed, clover seed, beans (dry), hay (tame), potatoes, sugar beets.

Washington

Vegetables—Asparagus (table), cabbage, cantaloupes, onions, lettuce.

Fruits—Apples (commercial crop), grapes, peaches, pears, strawberries.

Grains—Barley, corn, oats, rye, wheat.

Field Crops—Hay (tame), hay (wild), hops, potatoes.

R. W. B.

MISCELLANEOUS NOTES

Meeting of the Columbus Chapter.—Interest in the monthly meetings of the Columbus Chapter continues. Twenty persons attended the symposium on the topic, "The Coöperative Study of Man," presented January 17. The speakers were Dr. J. F. Lyman, Dr. E. R. Hayhurst, Mr. A. K. Kurtz, and Dr. H. A. Toops, presenting the points of view of chemistry, psychology and statistics.

On February 28, twenty-five persons attended the symposium on the general topic, "Contribution to a Theory of Values." The speakers and topics were as follows: Dr. G. H. Sabine, "Some Contributions of Philosophy"; Dr. R. D. Williams, "A Contribution of Psychology"; Dr. Willis Wissler, "A Contribution to the Economic Theory of Values"; and Dr. H. S. Will, "Statistical Method in Relation to the Theory of Values."

The Chapter voted to dispense with the regular March meeting in the interest of coöperation with the Ohio Conference of Statisticians, which was held in Columbus, April 6, 1928.

The Spring Meeting of the Ohio Conference of Statisticians.—The spring meeting of the Ohio Conference of Statisticians was held on April 6, 1928, at the Ohio State University, Columbus, Ohio. The program of the all-day meeting was as follows:

EDUCATIONAL STATISTICS SECTION

Papers:

"A Statistical Investigation of the Difficulty of College Courses" (a semi-automatic inter-correlation device was exhibited)—S. M. Whinery.

"A Comparison of Methods of Solving the Mean and Standard Deviation" (illustrated by examples on calculating machines scattered through the audience)—H. A. Toops.

Symposium on "What Should Be Taught in College Courses in Statistics and How"—B. R. Buckingham. General Discussion.

BUSINESS STATISTICS SECTION

Papers:

"New Formulas for Computing the Trend of a Time Series"—H. S. Will.

"Kinetic Business Forecasting"—W. A. Baude.

"The Use of Mathematics in Forecasting"—Ralph L. Dewey.

Discussion: Led by H. G. Brunsman.

SYMPOSIUM ON THE BUSINESS SITUATION (DINNER MEETING)

Joint meeting of the Columbus Bond Club and the Ohio Conference of Statisticians in coöperation with the Columbus Chamber of Commerce, the Taylor Society and the Bureau of Business Research of the Ohio State University.

Papers:

"A Review of Blast Furnace Forecaster and Forecast for 1928"—B. B. Smith.

"A Forecast of the Volume of Construction Contracts Awarded in 1928"—Spurgeon Bell.

"The Shadows on the Business Sun"—L. H. Sloan.

It was estimated that two hundred and fifty persons attended the dinner meeting in the evening.

The following officers of the conference were elected for the ensuing year: President, Mr. Bradford B. Smith, Cleveland Trust Company; Vice-President, Business Section, Mr. W. A. Baude, University of Cincinnati; Vice-President, Educational Section, Mr. H. A. Toops, Ohio State University; and Secretary-Treasurer, Mr. Willis Wissler, Ohio State University.

The Washington Meeting.—The Washington Statitiscal Society held a special meeting on February 3 in the Oak Room of the Raleigh Hotel in honor of Dr. Carl Snyder, President of the American Statistical Association.

There were also present as guests of the Society: Professor G. W. Warren of Cornell University, Dr. F. C. Mills of Columbia University, and Dr. Holbrook Working of Stanford University.

Talks were made by the guests of the society on the general subject: "The Problem of Wage Level in Relation to Farm Prices and National Prosperity."

Employment Statistics.—The Committee on Governmental Labor Statistics of the American Statistical Association has been called on to advise about more adequate statistics on employment and unemployment as a basis for legislation to be introduced into the Senate. A detailed memorandum on the subject has been prepared by a subcommittee.

It recommends that to the present collection of employment statistics on manufacturing there be added these industries: mining and quarrying, building construction, agriculture, transportation and communication, retail and wholesale trade; and such other industries as may be important to include.

The plan now in effect for coöperation between State and Federal Governments is also advocated, but in regions where no state collections are in progress the Federal Bureau of Labor Statistics is urged to publish the data for each state or for the areas set up in the Federal Reserve System and for smaller sections and for cities.

The discussion of unemployment and its extent which has given rise to considerable difference of opinion has again focussed attention upon the need for more adequate statistics. Whereas in 1921 no adequate plan had been made, it is now possible to recommend with some confidence the plan upon which the Committee has been at work since 1922.

United States Bureau of Labor Statistics.—During the past quarter the Bureau of Labor Statistics has finished the field work on the study of wages, hours, and working conditions in cotton gins, cotton compresses, and cotton-seed-oil mills. The first article based on this survey will appear in the May, 1928, *Monthly Labor Review*, and will cover cotton gins.

Field work on the investigation of wages and hours in the manufacture of electrical equipment and appliances in household and office use has been finished. Publication of the data obtained will be made in the *Labor Review*.

The collection of data on wages and hours in cotton-goods manufacturing and in woolen and worsted-goods manufacturing has been started. On May 15 the regular survey of union scales of wages and hours of labor will be taken up, and on June 1 the regular cost-of-living study.

The study of public service retirement systems, referred to in previous issues of this JOURNAL, is practically completed. The study of trade-union activities is being continued, and articles on the following topics have appeared in the *Labor Review* during the past quarter: Trade-union old-age pensions and homes for the aged and tubercular, and American trade-unions and the problem of unemployment.

Commerce Year Book.—The Bureau of Foreign and Domestic Commerce has instituted a new departure in its publication of the *Commerce Year Book*. The issue for 1926 has been presented in two parts. Part II has recently appeared entitled "Foreign Countries," a considerable expansion over the section formerly devoted to this material. This practice of separate publication of domestic and foreign material will be continued in the future. It is expected that the next issue on foreign countries will be ready for distribution in September, 1928, and will bear that date. All future issues will carry the date of the year of publication.

Maternal Mortality.—The study of maternal mortality which is being conducted by the United States Department of Labor, Children's Bureau, in coöperation with the state departments of health, at the request of the State Medical Societies is now under way in nine states: Kentucky, Maryland, Michigan, Minnesota, Nebraska, Oregon, Rhode Island, Virginia and Washington. The State Medical Societies of Wisconsin and Alabama have requested that the study be made. Several other states are considering the project.

The general plan of the study is to obtain from the State Department of Vital Statistics the death certificates of all women dying from causes associated with childbirth and the birth certificates which match these death certificates. A competent physician then secures the woman's medical history prior to the pregnancy, the prenatal care, and the conditions and procedure of the delivery from the attendant at birth and the attendant at death. The completed schedules are sent to the Children's Bureau, which will tabulate and summarize the findings.

Statistics in Canada.—Canadian annual trade statistics have, in the past, been published for the Dominion fiscal years ending March 31. However, as the production statistics of the country are compiled for the calendar year, it has been decided to issue, in addition to the trade report for the fiscal year, a trade report for the calendar year. The first of these reports, covering the calendar year, 1927, with comparative figures for 1926, has just been issued, and will be found useful in correlating the statistics of external trade with production statistics.

Under Canadian legislation, the Dominion Bureau of Statistics, besides the decennial census of the whole country, conducts a quinquennial census of the three Prairie Provinces. Separate reports containing the results of the quinquennial census of 1926 have now been issued for the provinces in question, Manitoba, Saskatchewan and Alberta.

Social Science Research Council Committee on Population.—In order to lay a foundation for a program of research in the field of population, the Advisory Committee on Population of the Social Science Research Council is making a survey of research now being carried on in this field. Information is desired upon all projects of research in population, whether made by descriptive, historical, statistical, or other methods. The Committee conceives the field of population research as including in its scope not only vital statistics and demography, but also studies of population groups, their elements, characteristics, qualities, activities, and changes. Among the specific topics to be covered are: population and its changes, population theories; mortality; births and birth-rates; immigration, internal migration; races and nationalities; eugenics; morbidity, sickness and health surveys; families, marriage, divorce legitimacy, children; man in relation to geography, density of population, city and regional planning, food supply, natural and economic resources in relation to population; defectives, institutional populations of all types; economic conditions, such as

wages, economic classes, employment of women, occupations, standards of living, in relation to population; mental efficiency, mental qualities of the population; education, training, and literacy of the population; citizenship, naturalization; and disasters such as flood, earthquake, famine, war, and pestilence, in relation to population.

The Committee will appreciate information which will make the report more complete. If any of the readers of this JOURNAL who are conducting research in this field have not already been asked to report in regard to their work, the Committee will be grateful if they will communicate with Dr. Robert M. Woodbury, 528 West 114 Street, New York City.

American Public Health Association Meeting in Chicago.—The fifty-seventh Annual Meeting of the American Public Health Association will be held in Chicago, Illinois, October 15–19, with headquarters at Hotel Stevens. The American Child Health Association and the American Social Hygiene Association will meet with this organization.

Louis E. Schmidt, M.D., is chairman of the local committee, and Arthur E. Gorman is secretary. Sessions are being arranged for health officers, child hygienists, public health nurses, laboratory technicians, vital statisticians, health education directors, food and drug experts, industrial hygienists and public health engineers.

M. Yves-Guyot.

Word has been received from France of the death, in late February, of M. Yves-Guyot.

M. Yves-Guyot was a leader in the statistical and economic thought of France. For many years he made frequent contributions in the fields of commerce, finance, production and economic forecasting.

He was a very active member of the Société de Statistique de Paris from 1876 to his death and for a period was its President. He has for years been an honorary member of the American Statistical Association as well as of many other societies.

Almost simultaneous with word of the demise of M. Yves-Guyot the following letter was received.

DEPARTMENT OF STATE
WASHINGTON

February 2, 1928.

The President of the American Statistical Association,
New York City.

SIR:

The Department transmits herewith by registered mail a medal which has been struck off by the Statistical Society of Paris in honor of the fiftieth anniversary of the initiation of Mr. Yves-Guyot into that Society and which was received from the American Ambassador at Paris with his transmitting despatch No. 6818 of November 18, 1926, with the statement that the medal was forwarded at the request of the Society, and that it had been especially made as a gift to the American Statistical Association among other American Societies.

The medal was at that time reported to be intended for the "American Statistical Society, 104 South Fifth Street, Philadelphia, Pennsylvania," and was therefore forwarded to that address by registered mail on December 14, 1926, but was returned by the postal authorities with the statement that the Society had not been found at the address given. The Department has only now learned through the American Embassy at Paris of the correct name and address of your Association, which accounts for the delay in the delivery of the medal.

I am, Sir,

Your obedient servant,
For the Secretary of State:
(Signed) D. R. CASTLE,
Assistant Secretary.

The medal is in bronze by Albert Herbemont. On the obverse is a *bas-relief* of M. Yves-Guyot; on the reverse

La Société de Statistique
de
Paris
a son
Presidente
en
Commemoration
du L^{eme}
Anniversaire
de son
Admission
1876–1926

M. Yves-Guyot is well known for his contributions in the statistical field. For many years he has been an honorary member of the American Statistical Association.

Personals

Mr. E. A. Goldenweiser, Director of Research and Statistics, Federal Reserve Board, spent the month of April in London, Paris, and Berlin. In Paris, he attended a conference of statisticians of banks of issue, called by the Economic Section of the League of Nations.

Professor Stuart A. Rice of the Department of Sociology of the University of Pennsylvania is on leave of absence for the academic year and is devoting the year to a study of methods of research, with emphasis on quantitative technique. Professor Rice is carrying out his project in coöperation with the National Social Science Research Council.

Miss Leone E. Chesire of the University of Iowa has accepted a statistical position with the United States Forest Products Laboratory at Madison, Wis., beginning February 1.

ADDITIONAL COMMITTEE APPOINTMENTS

Advertising Committee (new members)

Mr. Dean Langmuir
Mr. C. A. Hoppock
Mr. Virgil Jordan

MEMBERS ADDED SINCE MARCH, 1928

Arthur, Henry B., Harvard Economic Society, Inc., 1340 Massachusetts Avenue, Cambridge, Mass.

Attwood, Adah, National Industrial Conference Board, Inc., 247 Park Avenue, New York, N. Y.

Bailey, Arthur L., 114 North Ingalle Street, Ann Arbor, Mich.

Bane, Frank, State Office Building, Richmond, Va.

Baridon, Roger W., Hambleton and Company, Providence, R. I.

Barnette, Gaspar C., Statistical and Planning Department, The Wool Institute, 2 Park Avenue, New York, N. Y.

Barrows, Fred B., Rhode Island Hospital Trust Company, Providence, R. I.

Bartlett, Wade H., University of Texas, Austin, Texas.

Behrens, Carl F., Professor of Finance, University of Detroit, Detroit, Mich.
Borgward, F. William, Assistant Professor of Statistics, Syracuse University, Syracuse, N. Y.
Bradshaw, Frederic H., Thompson Ross and Company, 110 South East Avenue, Oak Park, Ill.
Breckinridge, Dr. Sophonisba P., Graduate School of Social Science Administration, University of Chicago, Chicago, Ill.
Broms, Allan S., The Graphex Company, 110 East 42 Street, New York, N. Y.
Brown, Zena, Keuffel and Esser Company, 300 Adams Street, Hoboken, N. J.
Buchanan, Malvern C., John Wanamaker, Philadelphia, Pa.
Burns, Arthur F., Department of Economics, Rutgers University, New Brunswick, N. J.
Bushey, J. Hobart, University of Michigan, Ann Arbor, Mich.
Carl, Leslie M., United States Department of Agriculture, Bureau of Agricultural Economics, Des Moines, Iowa.
Chandler, Harley W., Registrar, University of Florida, Gainesville, Fla.
Chapman, C. C., The *Oregon Voter*, Portland, Ore.
Clarkson, Katherine, Statistical Department, National Industrial Conference Board, 247 Park Avenue, New York, N. Y.
Conant, Richard K., Commissioner, Massachusetts Department of Public Welfare, State House, Boston, Mass.
Conover, A. Wilson, Metropolitan Life Insurance Company, 1 Madison Avenue, New York, N. Y.
Cook, C. E., Open Court Publishing Company, 339 East Chicago Avenue, Chicago, Ill.
Cowie, William R., 429 West 117 Street, New York, N. Y.
Cooley, Charles P., Jr., Thompson Fenn and Company, 56 Pearl Street, Hartford, Conn.
Craig, Madelyn, Association for Improving the Condition of the Poor, 105 East 22 Street, New York, N. Y.
Cronemeyer, Carl E., Department of Rural Education, State College, Pa.
Daggit, Edmund M., American Cotton Growers' Exchange, 316 Cotton Exchange Building, Memphis, Tenn.
Dahn, Donald Burroughs, 526 South Fifth Avenue, Ann Arbor, Mich.
Dargan, E. P., Cornell University, Ithaca, N. Y.
Davies, Richard G., University of Texas, Austin, Texas.
Diamant, Hendrik A., Stone, Webster and Blodget, Inc., 120 Broadway, New York, N. Y.
Drach, Gertrude M., Bureau of Business Research, University of Pittsburgh, Pittsburgh, Pa.
Drake, Charles A., Professor of Psychology, Adelphi College, Brooklyn, N. Y.
Duke, William B., Harvard Graduate School of Business Administration, Soldiers Field Station, Boston, Mass.
Duncan, Julian S., Columbia University, New York, N. Y.
Eastlack, Joseph O'Leon, Inter-State Milk Producers Association, 212 North Broad Street, Philadelphia, Pa.
Elliott, G. M., 24 Federal Street, Boston, Mass.
Ellsworth, Von T., Tax Research Department, California Farm Bureau Federation, University of California, Berkeley, Calif.
Fales, H. Marshall, Jr., American Telephone and Telegraph Company, 195 Broadway, New York, N. Y.

Fletcher, Ralph C., Instructor in Economics and Statistics, Washington University, St. Louis, Mo.
Foscue, Professor Augustus W., Jr., Southern Methodist University, Dallas, Texas.
Geddes, Miss Anne E., Research Bureau, Welfare Council of New York, 265 Henry Street, New York, N. Y.
Graue, Erwin, Instructor in Rural Economy, New York State College of Agriculture, Ithaca, N. Y.
Green, Grace H., Eastside High School, Paterson, N. J.
Gruehn, Herman L., United Gas Improvement Company, 613 Woodlawn Avenue, Collingswood, N. J.
Hainsworth, R. G., Bureau of Agricultural Economics, Aurora Hills, Alexandria, Va.
Hall, James L., Henry L. Doherty and Company, 60 Wall Street, New York, N. Y.
Hawkins, Ralph C., New York Telephone Company, 140 West Street, New York, N. Y.
Hayhurst, Emery R., Professor of Hygiene, Ohio State University, 1925 Concord Road, Columbus, Ohio.
Heck, J. F., Brown Company, Berlin, N. H.
Henriksson, Curt, 500 Riverside Drive, New York, N. Y.
Hobbs, Franklyn, Central Trust Company of Illinois, 125 West Monroe Street, Chicago, Ill.
Holmes, Mildred, 8 Shackford Street, Eastport, Me.
Jenks, Elizabeth, National Bureau of Economic Research, 474 West 24 Street, New York, N. Y.
Kingsbury, Susan Myra, Professor of Social Economy and Director of Carola Woerishoffer Graduate Department, Bryn Mawr College, Bryn Mawr, Pa.
Kirchner, John B., Southwestern Bell Telephone Company, St. Louis, Mo.
Kohl, Gerald S., New York Title and Mortgage Company and American Trust Company, 135 Broadway, New York, N. Y.
Krugman, Morris, Brooklyn Boys' Continuation School, 1150 President Street, Brooklyn, N. Y.
Latta, W. J., Jr., Bell Telephone Company, 1835 Arch Street, Philadelphia, Pa.
Limber, Ralph C., Bureau of Statistical Research, University of Denver, Denver, Colo.
Longley, Willard V., Professor of Farm Economics, Nova Scotia Agricultural College, Truro, Nova Scotia.
Lorge, Irving, Institute of Educational Research, Teachers College, Columbia University, New York, N. Y.
McCombs, Carl E., National Institute of Public Administration, Chappaqua, N. Y.
MacLillie, Charles H., Walsh, O'Connor and Company, 225 Montgomery Street, San Francisco, Calif.
Magee, Mabel A., 5319 Kimbark Avenue, Chicago, Ill.
Magill, Walter H., School of Education, University of Pennsylvania, Philadelphia, Pa.
Maher, Amy G., Information Bureau of Woman's Work, 305 Commerce Guardian Building, Toledo, Ohio.
Melnikow, Henry P., Pacific Coast Labor Bureau, 202 Underwood Building, San Francisco, Calif.
Meranski, Sophie R., Commonwealth Fund, Division of Publications, 578 Madison Avenue, New York, N. Y.
Merchant, Professor Charles H., Department of Agricultural Economics, University of Maine, Orono, Me.
Meyer, Walter E., Yale Club, 50 Vanderbilt Avenue, New York, N. Y.

Michael, William C., 112 Marion Street, Elmhurst, Ill.
Miller, Lee, 15 Oxford Street, Cambridge, Mass.
Mirlin, Mrs. Ada Beney, National Industrial Conference Board, 247 Park Avenue, New York, N. Y.
Mitchell, Harold H., American Child Health Association, 190 30 Street, Jackson Heights, N. Y.
Moll, Jewell, Case Pomeroy and Company, 60 Beaver Street, New York, N. Y.
Monroe, Edna, 195 Claremont Avenue, New York, N. Y.
Murray, Keith A. H., Farm Management Department, Cornell University, Ithaca, N. Y.
Neprash, Jerry A., Columbia University, New York, N. Y.
Nybolle, Hans C., State Statistical Department, Civil Service of the Government, Copenhagen, Denmark.
O'Donnell, James E., Westinghouse Electric and Manufacturing Company, 10 High Street, Boston, Mass.
Piser, Leroy M., Research Section, Federal Reserve Bank, New York, N. Y.
Pope, James D., Experiment Station, Auburn, Ala.
Porter, Stuart P., 2000 Second Avenue, Detroit, Mich.
Pote, Horace W., Statistical Department, American Radiator Company, 4201 Duncan Avenue, St. Louis, Mo.
Powell, Oliver S., Federal Reserve Bank of Minneapolis, 3439 Pleasant Avenue, Minneapolis, Minn.
Pressey, Dr. Sidney L., Ohio State University, College of Education, Apartment 3, 14 Twelfth Avenue, Columbus, Ohio.
Prosnitz, Ludwig B., C. P. A., 225 Fifth Avenue, New York, N. Y.
Puerschner, Ottilie, Association for Improving the Condition of the Poor, 105 East 22 Street, New York, N. Y.
Randall, Alexander B., Simon and Simon, Architects, 249 South Juniper Street, Philadelphia, Pa.
Randolph, Clara F., The Children's Bureau, United States Department of Labor, Washington, D. C.
Reilly, Dr. William J., Bureau of Business Research, University of Texas, Austin, Texas.
Rocca, Giuseppe C., with Commercial Attache, Cuban Embassy, Washington, D. C.
Sahlin, Carl F., The Wright Company, 229 Fourth Avenue, New York, N. Y.
Sasuly, Max, 460 Prospect Street, New Haven, Conn.
Schneider, David M., Bureau of Jewish Social Research, Room 1304, 114 Fifth Avenue, New York, N. Y.
Schutz, H. H., United States Department of Agriculture, Box 1057, Austin, Texas.
Schwarz, Theodore O., Michigan Bell Telephone Company, 1365 Cass Avenue, Detroit, Mich.
Sevely, Alfred A., 27 William Street, New York, N. Y.
Sherman, John F., The Sherman Corporation, 31 Milk Street, Boston, Mass.
Shultz, Dr. Birl E., Personnel Department, New York Stock Exchange, 11 Wall Street, New York, N. Y.
Slutsky, Helen F., Statistical Department, Fairchild Publications, 8 East 13 Street, New York, N. Y.
Smith, Arthur J., LaSalle Extension University, 4101 South Michigan Avenue, Chicago, Ill.
Smith, Dan T., Stanford University, Calif.
Spafford, Justin, 12 Halsted Place, Rye, N. Y.

Taylor, Maurice, Federated Jewish Charities, Boston, Mass.
Tebbutt, Arthur R., The Harvard Economic Society, Inc., Cambridge, Mass.
Thomas, Michael S., 315 Lincoln Road, Brooklyn, N. Y.
Tilton, Arthur Van Riper, Thomson, Fenn and Company, 56 Pearl Street, Hartford, Conn.
Trapp, Cordt, University of Copenhagen, Copenhagen, Denmark.
Trivanovitch, Vasso, National Industrial Conference Board, 247 Park Avenue, New York, N. Y.
Vance, Howard, Industrial Research Statistics, 578 79 Street, Brooklyn, N. Y.
Van Cleaf, Annabel, National Industrial Conference Board, 247 Park Avenue, New York, N. Y.
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Vernon, John J., Virginia Agricultural Experiment Station, Blacksburg, Va.
Vorenberg, F. Frank, Gilchrist Company, Boston, Mass.
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REVIEWS

Die Prognose der Schweine Preise, by Arthur Hanau. Vierteljahrshefte zur Konjunkturforschung, Sonderheft 2. Berlin: Reimar Hobbing. 1927. 41 pp.

It has been evident for some time that while the British school of statistical pioneers, notably Pearson, Bowley, and Yule, forged the first weapons of statistical investigation, American economists have led the way in putting them to practical use in economics. Of course our superior resources in the way of basic series of data, clerical help, and mechanical equipment, should not be overlooked as contributing causes. This practical application led American workers to make many improvements in the analyses of time series and in the study of relationships, and both the quality and quantity of statistical research in economics have been constantly growing. It would now appear that European investigators have conceded the initiative in this field to American workers, since during recent years economic research institutions have been established in Great Britain, Germany, and Russia, modeled quite closely after American examples. The work of these European research bureaus has been mostly devoted to describing the general economic situation through the development of basic data, the construction of indexes of price and production, the analysis of series into seasonal, trend, and cyclical elements, and the study of the relations and sequences of the movements of the several series. Until this paper on hog prices appeared, however, no European investigator, so far as I am aware, had attempted to apply to the analysis of the price of an individual commodity the methods of price analysis and statistical price forecasting which have been developing in this country for some years—methods which are far removed from the first British explorations in this field. Herr Hanau has done a job of analysis and forecasting which reflects great credit on him, not only as the pioneer European worker in the European field, but as producing a contribution which ranks very well when compared with contemporary work of the same type in this country.

The author has grasped the possibilities and limitations of the methods very well. His statement of the philosophy of price forecasting is worth repeating: "The goal is the investigation of the causal connections, so that, from simple subsequent occurrences of the established causes, conclusions can be reached as to indicated future effects."

The study of Berlin hog prices shows (1) that prices are determined largely by changes in market supplies; (2) that changes in the relation of hog-feed prices (40 per cent potatoes and 60 per cent grain) to hog prices, forecast changes in supplies by 18 months; and (3) that changes in the number of sows on farms also forecast changes in supplies by 12 months. Using the last two factors, and also the feed-hog price ratio, in a multiple correlation analysis, the author found he could forecast monthly hog prices 5 months ahead, with a multiple correlation of 0.86 for the prices corrected for trend and seasonal, or 0.94 for the actual prices themselves. This result for the period 1896 to 1913 is as good as any American

student of hog prices has been able to obtain for the same period in this country. (Haas' comparable figure was $R=0.93$.)

The details of his analysis have been admirably abstracted in a Danish review, which I cannot improve upon, and am therefore quoting:

> The author, taking into consideration the special conditions in Germany, used as "feed unit price" the price for a feed consisting of 60 per cent grain and 40 per cent potatoes. The price relation between hogs and feed is then determined by dividing the current hog price by the "feed unit price" prevailing at the same time, taking into account a 12-month moving average for hog prices as well as for feed prices, in order to eliminate the incidental small irregularities in the monthly averages. The result of this investigation appears in a figure, which demonstrates the connection between the "ratio" and the supply 18 months later. In the years previous to 1904 this interval of 18 months is not as suitable as in later years, which obviously is due to the fact that the time for fattening has been shortened. It can consequently be stated that 18 months after the favorable price relation has occurred there will be large supplies and 18 months after a poor price relation there will be a small supply. Since the period of gestation is 4 months and fat hogs in Germany reach an average age of 10–11 months before they come on the market this difference of 18 months in time is easily explained. A few months have to be added because the farmer delays adjusting production in accordance with the price relation.
>
> Since supply and prices are closely connected with each other, one can therefore draw conclusions from the price relation between hogs and feed not only as to the future supply, but also as to the future hog prices. Even though the curves in the figure show very clearly a close connection between the price relation and the future supply it must not be forgotten that different conditions can enter in and influence the farmer's inclination to adjust production according to the price relation. In the farming business hogs have to compete for the available feed stuffs, on an equal footing with other domestic animals, cattle and sheep, together with the possibility of the sale of feed stuffs produced on the premises. For this reason it is desirable to find other factors to support price forecasting, and the change in the number of sows over one year appears as a specially serviceable factor. The investigation has shown that the trend in the number of sows is a sure indication as to the direction hog prices will take in the next year. In a figure the fluctuations for hog prices during the period surveyed are compared with the fluctuations in the number of sows in such a manner that the price movement at a given period of time is placed opposite the movement in the number of sows one year earlier. It can therefore be recorded that if the census of sows shows an increase as compared with the number in the previous year, hog prices will fall during the period until the next census; conversely the same.
>
> While it is thus actually possible to undertake a forecast of hog prices on the basis of price relation between hogs and feed alone and on the basis of the movement in the number of sows, alone, still the author, through his investigations, has come to the conclusion that the safest forecast, the best prognosis, is reached by connecting the two factors with a third factor: the absolute feed price. This combination can also be expressed in a mathematical formula (forecasting formula), by the use of this formula the author has been able, on the basis of material available at least 5 months previous, to "forecast" prices during the period 1896–1913 with a startling conformity, as is shown in a figure.[1]

Applying the same regression equation to data since 1924, Hanau found it possible to work out a forecast of hog price changes 11 months ahead of the last date used in the computations. On this basis he presents a forecast for 1927, worked out in February, which now proves to have been rather remarkably accurate. The forecasted prices together with the prices which actually pre-

[1] *Landbrugsraadets Meddelelser*, October 20, 1927. "En tysk Undersögelse af Produktions-og Afsaetningsforhold for Svin og en Metode til Forudsigelse af Svinepriserne i Tyskland." I am indebted to Miss Ingeborg S. Erönbold, of the Bureau of Agricultural Economics, for the translation from the Danish.

vailed (the latter based on information furnished by the Foreign Section of the United States Bureau of Agricultural Economics), are as follows:

PRICES OF HOGS AT BERLIN, 80–100 kg.

Month	Forecast price	Actual price
1927	RM per 100 kg.	RM per 100 kg.
March	114	120
April	109	115
May	107	113
June	108	118
July	117	122
August	127	123
September	131	143
October	131	133
November	127	124
December	124	113

While the actual price did not go quite so low as the forecasted price in the spring, and went lower in the fall, the general movement through the year, and the months of highest and lowest price, were indicated quite well. On the other hand, the failure to agree during the year seems to bear some relation to concurrent changes in the hog situation in the United States, and throw some doubt on the correctness of the author's conclusion that hog prices in Germany are practically independent of the hog situation elsewhere.

Certain of Herr Hanau's conclusions agree remarkably with those reached from parallel American investigations. Among these might be mentioned (a) that the mere size of the feed crop (potatoes) alone does not affect subsequent hog prices; (b) that cattle prices have little effect upon hog prices; (c) that the prices for pigs and light hogs vary concurrently with fat hog prices, instead of preceding them; and (d) that so far as hog prices are concerned, variations in demand are entirely overshadowed by variations in supply.

One conclusion might be questioned: That the German hog prices are practically entirely determined by German production, and that the not inconsiderable volume of imports is insufficient to affect the market. While it is possible to explain most variations in German prices by German conditions, the author has overlooked the point that supplies of hogs in Germany, responding to the hog-feed-hog-price cycle there, tend to vary at just about the same times that supplies of hogs in the United States change in response to changes in the corn-hog cycle here. Between 1900 and 1914 every major movement in Berlin hog prices was paralleled by a similar swing in Chicago hog prices, American prices tending to lag a few months; and every cyclical swing in German hog marketings was paralleled by a similar swing in our marketings. The phenomena are so closely parallel that the situation in either country may be fairly well accounted for on a domestic basis, yet a complete explanation would probably include the variations in the rest of the international hog market as well as in the particular country. The irregularities in the Berlin prices during the past year as contrasted to the forecast, which were noted before, and similar difficulties in forecasting hog prices in this country largely on the basis of our domestic conditions, all point to the mutual dependence of both markets and the necessity for bringing the entire situation within the forecasting equation.

Herr Hanau has made a valuable contribution to the field of price analysis, and one which should stimulate workers in this country to fresh efforts in the field of the international dependence of commodity prices.

MORDECAI EZEKIEL

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The Economics of Instalment Selling; A Study in Consumer's Credit, with Special Reference to the Automobile, by Edwin R. A. Seligman. New York: Harper and Brothers. 1927. Two vols. xii, 357, and 623 pp.

The economist, the merchant, the banker, the consumer, and the moral philosopher as well, has each had his view and at times said his say on the subject of instalment selling. Professor Seligman in his ambitious two-volume work has not avoided the issues raised by all of these observers and spokesmen. In his undertaking he has been aided, as he states in his preface, by a number of his professional colleagues, and a corps of younger assistants and has had put at his disposal the "complete records" of General Motors Corporation and the General Motors Acceptance Corporation.

The first of the two volumes gives the setting of the problem, states the issues and discusses them; the second is a volume of statistical appendices, the conclusions and summaries of which are called upon as occasion demands to support the argument of Volume I. This second volume consists of seven separate studies, five of which were individually conducted by colleagues of the author. These studies cover an interesting range. Instalment selling in real estate; the volume of retail sales; consumer credit; instalment selling in certain lines of merchandising; the effects of instalment selling of automobiles; repossession of automobiles sold on instalments; the effect of a depression on instalment sales payments—these phrases state the themes of the volume. The studies differ considerably in difficulty, in method of approach, in available facts, in type of analysis, and in style of presentation. There appears to be throughout a careful effort to point out the possible deficiencies and limitations of the data. The variety of problems faced and the methods used make Volume II worth the careful attention of statisticians.

One important statistical study is presented in Volume I. This study is undertaken to measure the volume of instalment selling. The author concludes that the selling price of so-called consumption goods represented by instalment paper is about 4.5 billion dollars per annum and that the average amount of outstanding instalment paper is approximately 2.067 billions. These figures are strikingly smaller than those presented about a year and a half ago by Milan V. Ayres, with which the author carefully compares them, and which indicated that yearly instalment sales ran close to 6 billions.

The major function of Volume I, however, is to present the case of instalment selling. The problem is stated as a series of problems centering around consumer's credit. First of all "what is consumer's credit?" Is it a direct outcome of earlier types of credit? Should all forms of consumer's credit be lumped

together for discussion or should credit for necessaries be distinguished from that used to provide luxuries? What, if any, are the special features of instalment credit that tend to set it out as different from other forms of consumer credit?

For considering all of these problems the author sets up standards which run in the customary terms of economic analysis and which characteristically accept the tenets of the economic faith. "Does consumer credit tend to rationalize spending or to accomplish the reverse?" "Does instalment credit . . . tend to discourage the consumer or . . . to stimulate . . . to greater production?" "Does instalment credit tend to encourage or to discourage savings?" "Does it represent a provident or an improvident expenditure?" "Is it calculated to retard or to accelerate the process of the accumulation of individual and social capital?" "Does instalment selling increase demand or does it merely advance the time when demand becomes effective?" "Will it . . . intensify the consequences of a business crisis?" These are typical of the tests set up.

Most readers will not quarrel with the adequacy of these tests. But there are some instances in which the reader will wish they had been applied more sternly. Such a case is the handling of the question whether instalment buying enlarges demand or only advances the time when demand becomes effective. (Treated in Volume I, pages 279–283.) This question has had wide discussion. In contending that instalment credit augments purchasing power the author's reliance is placed partly upon quotations from two other economists although each has so hedged his statement, as the author points out, as to make it somewhat fragile support. But the main dependence is upon reasoning. The logic used is "the fact that consumption may mean a productive utilization and that it may thus modify the income flow to the individual." (Page 282.) "How can it be denied," the author asks, "that we are here dealing with a productive utilization of wealth?" While it undoubtedly cannot be denied that certain kinds of immediate consumption may add to one's productivity, there are some who will wish the author had gone further in considering:

(a) What reason there is to believe that the consumer, who certainly does not always (even in the case of automobiles, for which the best case is made) have an eye to productive results in his consumption, will direct his instalment buying to those articles which will "augment" and not merely advance his purchasing power.

(b) How good a case for augmented productive power through advanced consumption can be made for the several commodities which actually are the chief ones purchased on instalments? (Automobiles, furniture, clothing, pianos, radio, and property improvement are the commodities sold on instalment to the extent of 100 millions or more. Volume I, page 117.)[1]

(c) Even if the consumer does choose those goods that will augment his purchasing power how can one satisfactorily measure the increase against the added costs? (That "instalment selling undoubtedly increases the cost of the

[1] It should be said here that the author in other places points out that a better case may be made for buying some goods on instalments than others, but the very practical issue here raised appears to be passed by.

product" is the conclusion of the author. Volume I, page 335.) The statement applicable to this point (page 295 of Volume I), "The net result is likely to be beneficial" is not very conclusive.

(d) If the purchasing power that went into instalment buying—say of automobiles in the last five years—had not gone there, would it have found expression in effective demand elsewhere? In other words is it possible that instalment selling of consumer's goods is essentially a method by which demand is merely shifted, though possibly shifted into the hands of those who obtain a larger consumer's surplus for the dollars spent?

(e) What justification is there for the oft-heard theory that instalment selling may, in times of depression, furnish a means of starting economic activity, which, even though it is regarded as the result of an "artificial stimulus" at the outset, develops into a wholesome and widespread era of prosperity?

Early in the work it becomes evident that in the author's mind the matter is at bottom a subjective one—a question of values. He says (Volume I, page 130) in concluding the list of tests, "The final problem accordingly concerns the essential nature of the automobile. Is the automobile a luxury or a necessity? . . . Is it a good or a bad innovation? . . . Is it socially desirable to stimulate the use of the automobile?"

With the philosophical statements which are naturally enough brought in as a result of this analysis some persons will be certain to disagree. One can only say that Hume and Voltaire, who are quoted, are convincing to those they convince and unconvincing to those they do not move, and of course the same must be said of the author when, as on page 172 of Volume I, he ventures to define "moral progress" and a little later states, "The real secret of life is thus to be sought in the productive utilization of wealth, as in the positive utilization of all our opportunities."

There will also be some disagreement with certain specific points in the discussion of the effects of the automobile. For example, "Under the conditions of modern American life, with its unremitting intensity of exertion, the need of relaxation becomes more pronounced than it is in other countries, or than it was in former times, when the pace was less killing." One cannot help wondering whether the idea of "the unremitting intensity of exertion" for most Americans nowadays as compared with the past or with other countries is not a little overdone in our time of shorter hours, recognized vacation rights, and relatively late entrance into vocations.

Finally when it is stated that, "In so far as the automobile, the telephone and the radio are augmenting the attractions of the farmer's career, they are contributing to the maintenance of what is still, and what will long remain, the foundation of American economic life" (Volume I, page 241), the question arises whether the contacts with town and city life made possible by the automobile have not done more to draw people from the farms than to keep them there.

The general conclusion of the work is a thoroughgoing approval of instalment selling. Some dangers are seen, some risks are indicated, but it is clearly the author's belief that instalment selling is here to stay and that it is fortunate that it is so. The final sentences are in these words:

> Is it not the part of wisdom to separate the chaff from the grain, to be on our guard against the obvious dangers, and to eliminate one by one the improper practices until, precisely as in the case of our banking structure, we may be able to establish fairly definite and generally accepted standards for distinguishing the sound from the unsound, the real from the specious? When instalment selling comes to be measured by these criteria, we may expect to learn that the innocuous and the salutary must not be confounded with the inappropriate and the regrettable, and that, in its ultimate and refined forms, instalment credit will be recognized as constituting a significant and valuable contribution to the modern economy.

The greatest value of the work is in bringing into one study many of the issues that have arisen concerning instalment selling and in collecting and presenting a large amount of data which may be brought to bear upon any point, commercial or general, with which a reader is concerned. In the opinion of the reviewer it is the comprehensiveness of the plan and the assembly of information that make the production significant rather than the general argument in which these are set.

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Industrial Prosperity and the Farmer, by Russell C. Engberg. Institute of Economics Series. New York: The Macmillan Company. 1927. xiii, 286 pp.

The scope and intent of this study may be judged from its final conclusions, which briefly stated, are as follows: Industrial fluctuations are only to a small extent responsible for the farmer's financial difficulties; it is not worth while for farmers to adjust their production programs to changes in demand or costs predicted on business forecasts; and the remedies suggested for business cycles are not likely to prove effective in stabilizing agricultural production and prices. The book consists mostly of an attempt to prove the first of these three statements, the other two growing out of or being largely incidental to the discussion of the first.

The proof of the first statement mostly rests upon a partial correlation analysis in which prices of potatoes, hogs, corn, oats, cotton, wheat and apples in their main marketing seasons are paired with pig-iron production for twelve-month periods ending the preceding March 31st, and at five other quarterly points following, in each case the volume of production for the same year as the prices being held constant. Following is a brief tabular summary (not the author's) of the results of this analysis.

It appears that the volume of production of the commodity is in every case much more important than the volume of industrial activity, if the squares of the respective partial r's are taken as a measure of this, as in the study, the least difference being in the case of cotton. The years indicated in parentheses are the reviewer's to enable the reader to visualize readily the periods of highest concomitance. It is pig iron for the twelve-month period with March 31st of any year as its midpoint that is most highly correlated with the December-following price of cotton; whereas it is pig-iron production of a whole year later that is most highly correlated with corn prices of the same date; in other words, the pig-iron

Commodity	Midpoint of production year for pig iron giving highest partial r	Production period for commodity	Date of price taken	Pig iron		Production of commodity	
				r	r^2	r	r^2
Potatoes.....	Sept. 30 (1927)	Annual total (1927)	Dec. 1 (1927)	.197	.039	.869	.755
Hogs.....	Dec. 31 (1927)	Pack Nov. to Feb. inclusive (1927–28)	Nov. to Feb. (1927–28)	.349	.129	.760	.578
Corn.....	Mar. 31 (1928)	Annual total (1927)	Dec. 1 (1927)	.235	.055	.720	.518
Oats.....	Mar. 31 (1928)	Annual total (1927)	Sept. (1927)	.308	.095	.771	.594
Cotton.....	Mar. 31 (1927)	Annual total (1927)	Dec. (1927)	.489	.239	.652	.425
Wheat.....	Sept. 30 (1927)	Annual world total (1927)	July to Oct. inclusive (1927)	.292	.085	.691	.477
Apples.....	Dec. 31 (1927)	Annual total (1927)	Oct. to March (1927–28)	.137	.019	.801	.642

production year which has most effect on corn prices is only three months old when it does this.

While Dr. Engberg explains very little about this wide range in the period of highest concomitance, he does indicate clearly that the coefficients in themselves do not show which way the causal sequence operates, and very properly suggests that the correlation appearing may in large measure be due to common causations. Most readers would like to have seen the relation between pig-iron production and commodity production carefully measured and explored. There is some discussion of it in the case of cotton, hogs and wheat in the last three chapters of the book which analyze the whole problem in more detail for these three commodities.

The part of the whole analysis which is most slighted is the relation between prices and subsequent production. Little analysis of this sort is now available, and Dr. Engberg did not have time to make any of his own. One bit of analysis with respect to this seems to the reviewer to be even misleading, namely, that since cash sales of farm products amount to an average of $777 per farm per year, and cash outlays only $325, farmers cannot gain from curtailing output when prices are low. (Pages 22–25.) There is abundant evidence elsewhere in the study that farmers do buy less fertilizer and hire less labor and feed less heavily (see pages 41 and 98), when price ratios are unfavorable, and it is not difficult to show that they gain from so doing. While Dr. Engberg is sound in his main contention that indirect costs are of great importance in agriculture, he carries his point too far. Thinking in terms of marginal receipts and expenditures would have saved him this error.

Of general comments of an adverse nature, the reviewer has only three, namely, that the quantitative analysis has not been carried through far enough nor tied up enough with the preliminary description and qualitative analysis—a common failing of young research workers of this generation; that the analysis is too mechanical on the whole, for example, not singling out for any special treatment the recent agricultural depression; and third, that the conclusions are probably a bit overdrawn. Nevertheless, the study is much worth while, and is an excellent

beginning upon a very difficult problem. It was carefully laid out in advance, and the presentation is orderly and clear. Economics is to be congratulated upon the fact that the Institute of Economics has since put Dr. Engberg at work upon the companion problem of the effect of agricultural fluctuations upon industry. Work on this second problem will undoubtedly throw light upon many dim places in the field.

JOHN D. BLACK

The Distribution of Industrial Occupations in England, 1841–61, by Clive Day. Transactions of the Connecticut Academy of Arts and Sciences, Volume 28, pp. 79–235, March, 1927.

The purpose of this study is to determine the extent of the market for industrial products in the period under investigation. Assuming that the per capita consumption is uniform and that the consumer is supplied by the producer nearest at hand, we can determine the extent of the producer's market from the local distribution of consumers and producers. (Page 88.) If all razor makers are located in one county, we may conclude that the market for razors is national in scope. If shoemakers are distributed among all counties in exact proportion to population, the market is local.

In his study of industries with a national market, the author for the most part excludes London since its economic life was largely commercial rather than industrial. Some industries were, however, concentrated largely in London, and a special chapter is devoted to them. Exclusive of these metropolitan industries, the remainder are designated as national, provincial and local depending upon the extent of the market in each case.

The author calls an industry *national* if more than 50 per cent of the persons engaged in it were concentrated in districts comprising less than one-quarter of the total population. The industry is termed *metropolitan* if more than 50 per cent of the workers were concentrated in London, which at that time contained about 12 per cent of the total population. An industry is termed *local* if its workers are quite evenly distributed everywhere. The *provincial* industry occupies a point intermediate to the local and the national.

Three types of measures are used to indicate the degree of concentration or localization of an industry, as follows:

1. The diagramatic method. A base line is laid out representing the total population exclusive of London. At the extreme right of this base line, a space is laid off equal to the total population of the county with the greatest concentration of workers in the given occupation. A rectangle is then erected on this base, the vertical scale representing the number of workers in the given occupation per 10,000 population. Proceeding from right to left, a rectangle is then drawn for the remaining counties in the order of concentration of workers. The result is a picture of the localization of the industry.

2. The index of concentration. This index states the "percentage of the total population included in those counties (or districts) in which one-half of the workers are domiciled." Thus an index of 95 means that half of the workers in a

given industry live in districts which include only 5 per cent of the total population. An index of 75 or more is requisite to class an industry as national.

3. Coefficients of deviation.

(a) Standard coefficient (the standard deviation divided by the mean). Industries are not regarded as national unless the standard coefficient is greater than unity. Most of the industries classed as provincial have a coefficient ranging from 0.5 to 1.0.

(b) Quartile coefficient (the difference of the first and third quartile divided by their sum).

Chief emphasis is placed upon the index of concentration and the standard coefficient. The author finds a high positive correlation between the results of these measures of distribution. Neither is able, however, to give any indication of the exact form of the distribution and in this regard the diagramatic method is superior. The index of concentration is, the author believes, on the whole the best measure. The standard coefficient he finds unreliable for the measurement of industries with extreme deviations, particularly when the industry is highly localized in a small district which is accordingly given disproportionate weight.

The author raises the question why Pearson's coefficient of correlation cannot be used in a problem of this character. Would not a correlation of the two variables, (a) number in trade and (b) total population in each county, measure the localization of the industry? The answer is in the negative since in reality only one of the series is a true variable. Thus if the counties were adjusted so that all the districts had equal populations the only variable that would remain would be the number in the trade. The problem is essentially that of determining the deviation of a single series and not one of correlation.

Of the industries with a national distribution the textiles dominated. Three-fourths of the workers in national industries were employed in this field. Second in importance came the metal industries. Textiles and metals included seven-eights of the total population engaged in national industries. Among the other national industries were pottery, glass, hats, and gloves. Of industries localized in London, printing, publishing and book making was the most important. Some of the metropolitan industries required highly skilled labor such as the making of scientific and surgical instruments. Others flourished on cheap labor such as the artificial flowers industry, embroidery and trimming. Some of the industries appealed largely to the rich, such as the execution of crests and coats of arms. Provincial and local industries included masons, carpenters, blacksmiths, wheelwrights, butchers, millers, shoemakers, tailors and dressmakers.

Professor Day's study is of interest to the economic historian, but, in the opinion of the reviewer, its chief interest lies in the method which it develops in the measurement of the extent of the market and the localization of industries. This is a fascinating field for research and one that needs much cultivation. Professor Day has made a worth-while contribution which merits careful consideration and which should stimulate other studies of a similar character.

ALVIN H. HANSEN

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Introduction to the Mathematics of Statistics, by Robert Wilbur Burgess, Ph.D. Boston: Houghton Mifflin Company. 1927. vii, 304 pp.

The many statistical texts which have appeared of late in this country fall essentially into two classes: those written primarily by mathematicians, and those written primarily by specialists in other fields intended for use by workers in these fields. The former are largely theoretical and demand a considerable amount of mathematical preparation on the part of their readers. Furthermore, they are apt to contain little or no discussion of the really difficult problems, such as the correlation of time series, for the handling of which no completely satisfactory mathematical patterns have as yet been discovered; and their rules on practical statistical procedure are often at variance with the methods of the best statistical laboratories. The texts of the second class are usually limited as to their methods and are apt to be weak or unsound as to the mathematical principles that are involved.

The present introductory text differs from both of these classes. While it presupposes a mathematical equipment "equal to that of college students who have had one year of mathematics in college, including the theory of logarithms and elementary graphics," and while it gives proofs of most of the formulas that are involved, yet the treatment is so logical and clear and so well illustrated by numerical examples and graphs, that it may also be read with advantage by persons with a poorer mathematical background.

Distinguishing features of the treatment are: the chapter on ratio or percentage analysis; the clear discussion of the harmonic mean; the logical presentation of the difficulties connected with the construction and interpretation of index numbers; and the informative discussion of the various methods of measuring seasonal variation. No attempt is made to discuss methods of gathering data or the mechanical details of tabulation and graphing.

The author's expressed aim is "to bring together the practical and the mathematical methods of approach to statistical analysis." In this he has, on the whole, been successful, but his success is less marked in some chapters than in others. Thus, the discussion of sampling, which, according to Karl Pearson, is "the central problem of statistics," as well as the related question of probable errors is, in the reviewer's opinion, too brief. Furthermore, there is no discussion, in the chapters on correlation, of the relation between mathematical and statistical dependence, and between correlation and causation—concepts about which there is a good deal of confusion. Again, the meaning of the regression coefficients in regression equations with three or more variables is not related to the theory of linear dependence, nor is the rationale of curve-fitting given adequate treatment. But on these matters opinions may differ. The author probably considers most of these topics as not coming within the scope of an introductory text.

Graphic methods are not treated in a separate chapter, but each method is taken up along with a discussion of the principle which it is used to illustrate. The author takes the position that "some real thinking must underlie any graphic presentation to make it significant, and that logically the emphasis belongs on that thinking rather than on the graphic device." But a graphic device would

have assisted the reader in following the reasoning on page 140 leading to the formula for the mean deviation, and graphic devices would have been of even greater help in connection with the discussion of the two lines of regression and of the point binomial. (The third column in the table on page 138 should be lowered by one line.)

Mr. Burgess has written a well-balanced and lucid elementary outline of statistical methods which is not only sound in its theory but is also a safe guide as to practical method. In these days of the electric computing machine when statisticians in various fields take such delight in grinding out multiple regression equations in a dozen variables or more and in performing other heroic feats of computation, it is good to have Mr. Burgess' reasoned warnings, of which the following is a fair sample:

> Four-variable regression equations should, in the opinion of the writer, be used only with considerable caution, and the use of five or more variables is to be discouraged still more. At the best, these formulas give only an average relationship, the best there is, to be sure, of the first degree algebraically. But the assumption of the adequacy of a first-degree formula becomes increasingly dangerous as we increase the number of variables. . . .
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> In general, the writer believes that an intensive examination of two- or three-variable correlations, with full consideration of possible non-linear relationships, will be found more valuable than the cursory inspection implied by regression equations in four or more variables. (Page 279.)

HENRY SCHULTZ

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The British Coal Dilemma, by Isador Lubin and Helen Everett, with the aid of the Council and Staff of the Institute of Economics. New York: The Macmillan Company. 1927. 370 pp.

More than a half century has elapsed since Stanley Jevons issued his long-since famous warning regarding coal: "This is a question of that almost religious importance which needs the separate study and determination of every intelligent person." Despite this early recognition of inherent dangers in Britain's exploitation of her coal resources, the British coal industry remained in an unassailable economic position until 1913. This fact, however, is not to be construed as evidence of the capacity of private enterprise to avoid dangers and pitfalls once they have been pointed out by the students of industrial problems. The British coal industry, like Topsy, "just growed." A continuous expansion in British manufacturing and commerce with the extension of markets and the growth of world trade permitted the coal industry to remain profitable despite its inherent weaknesses. So long as it remained the "spoiled favorite of fortune" with "wealth washed to its shores by the mere tide of economic expansion," obsolescent equipment, waning resources, and rising costs were inadequate obstacles to continued profits; and so long as profits continued, the business men gave no serious thought to a coal problem. Indeed no "problem" existed. Then came the War. The complications anticipated by Mr. Jevons in 1865 became the confused and chaotic realities of 1926. It is with the story of these developments that the authors of *The British Coal Dilemma* are concerned.

The authors divide their discussion into three main parts. Part 1, The Sequence of Events, sketches the major facts in the transition in the British coal industry from pre-war supremacy to post-war confusion. Part 2, The Logic of Events, analyzes the fundamental causes of the post-war debacle. Part 3, Facing the Issues, devotes itself to a consideration of what can be done about it.

The intelligent American layman is aware of the fact that something is wrong with the British coal industry. The general strike of 1926 heralded that fact to all the world. What the layman quite generally lacks is an understanding of the causes basic to the British problem, and it is with regard to this question that the authors' analysis should prove particularly valuable. The British coal industry is old. For centuries some of her fields have been commercially exploited. While they have been made to yield an increasingly larger annual output in response to the growing needs of industry, they have done so only at steadily mounting costs. Coal is a waning resource. Deeper and deeper have sunk the shafts; thinner and thinner have become the veins. About one-half the coal mined in Britain today comes from depths greater than one-sixth of a mile; 23 per cent of it comes from depths greater than 1500 feet. The significance of these figures is appreciated when one considers that the average depths of shafts in the United States is but 260 feet, or one-third of the average depth of the shafts in Great Britain. In 1913, 55 per cent of the British output came from seams four feet and more in thickness. By 1924 this percentage had declined to 51 per cent. More than one-fifth the output now comes from seams less than 36 inches in thickness, a thickness considered unworkable in this country. Annual output, it is true, was increased during the first thirteen years of the century by 62,000,000 tons, but it was necessary to employ 346,000 additional workers to achieve this result. In terms of labor productivity this meant an increase of 45 per cent in the number of workers with but a 27 per cent increase in output. By 1924 the annual output per worker had fallen to a level 40 tons below that of 1913.

Meanwhile, in response to the efforts of organized labor, the British coal miner has been able to secure through increasing wages a larger quantity of the material requisites of comfortable living. Wages have mounted, hours have decreased. Likewise, the laborer's free income has increased through safety and health legislation. All this has worked to make the British coal mines the safest in the world, but it has done so at the cost of higher charges in coal production. Thus, cumulatively and consistently, costs have mounted.

The orthodox would have expected a way out of this dilemma of higher labor costs and waning resources through the introduction of improved technique. Not so in fact, however. British coal is mined and marketed today in a manner woefully inefficient when compared either with abstract engineering standards or the methods long prevalent in this country. The introduction of cutting machines has been slow. The haulage system, the most vital factor in the organization of a pit, is antiquated and uneconomical. The marketing of coal is both wasteful and inefficient.

The industry is characterized not alone by confusion from within, however, but worse still, perhaps, by shrinking markets from without. British foreign custo-

mers for coal are supplying their needs more and more through the development of the resource within their own borders or through purchase from more abundant and accessible sources.

And despite all these developments, both the efficient and the inefficient mines continue in operation—a fact of primary importance for those economists who, still clinging tenaciously to the simple faith of Adam Smith, look to competition as an effective regulator even in the field of natural resources. Competition has not insured the elimination of the unfit. Marginal mines have not gone out of business through the avenue of bankruptcy. Coal mining requires a specialized form of capital investment that can be neither withdrawn nor utilized for any other purpose. Bankruptcy may force coal operators out of business, but it does not force coal mines out of industry. With capital losses written off through reorganization, the inefficient mines remain to plague the system. The story in this regard is the same in England as in our own bituminous industry.

The authors recognize that the establishment of order in the British coal industry involves a complete reorganization—the setting up of some sort of control and coördination which takes account not only of the complexities of the coal industry itself, but of the ramifications of the coal problem into the whole field of British industrial life. While they do not commit themselves unequivocally to a program of nationalization, the authors recognize as woefully inadequate the program offered by the present owners of the industry. They realize that the initial impulse to organization must come from the Government and that there is necessity in Great Britain for a coördinated and socially planned development of economic activities in general if Great Britain is to recover something at least of her former competitive position in the world of commerce and industry.

The authors have brought to bear upon their task the double training of the economist and the research specialist. Into their research has come the breath of life through several months of first-hand contact with the British industry. Their study has been thorough; their analysis is logical; and their presentation, convincing. Altogether, *The British Coal Dilemma* represents an admirable statement of the problem and a thoughtful and judicious, though certainly an over-restrained, consideration of the meaning and way of remedy. It should prove of value not only to specialists in coal, but to all concerned with the problem of the social control of business.

GEORGE WARD STOCKING

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Die Industriekonjunktur—ein Rechenfehler! by Dr. F. Schmidt. Zeitschrift für Betriebswirtschaft, 2 Sonderheft. Berlin: 1927. 95 pp.

The post-war inflation in Germany has thrown into clear relief the inadequacies of the system by which business enterprises take account of changes in prices and in property values. Rigid methods of accounting, with their assumption of a stable monetary unit, allowed for easy changes only downwards, so as to protect the creditors from an inflation of assets. Gross miscalculation and a frittering away of capital in the confusion of a rapid monetary inflation were the re-

sults. Dr. Schmidt's expanded article may be interpreted as one of the effects of this experience, as an attempt to present the miscalculation of accounting as the cause of "normal" cyclical movements.

This Rechenfehler, the chief source of industrial fluctuations, is described by the author as follows:

> In times of rising prices, the increase in price of the means of production from the day of acquisition to the day of use is conceived by the entrepreneurs as profit, *i. e.* as income. This really amounts to a conversion of property into income and to an increase of the available means of purchase in such a way as to give rise to an abnormally large demand for goods, the latter resulting in a new price increase. During the crisis, the decline of prices which is caused by an over-expansion of production, is shortened by the practice of compensating a fictitious loss in property value from the gross returns. This diminishes income and profits so seriously that the smaller volume of purchasing power on the market results in an abnormally great price decline, which is lifted only gradually by a growing ease in the supply of money. (Page 72.)

Thus a mistaken conception of price margins is a result of the inflexible methods of accounting. For in times of rising prices the entries of means of production acquired at some time previous are kept at the old cost value, and are not revalued according to the higher "repurchase" cost. In times of crises and price decline it is the law and custom to enter the changes of prices immediately, but again no allowance is made for the decline in reproduction value, and the change in price is taken to be a direct loss.

The author distinguishes after Spiethof six phases of the business cycle: the decline, the first and the second rise, the peak, the period of an acute lack of capital, and the crisis. The essential upward miscalculation takes place during the second rise and at the peak, especially in the latter, where it gives rise to fictitious profits. After the crisis the decline is shortened by the effects of an accounting deflation, which results in a greater liquidity of money and credit. The fall in the value and volume of stocks and of outside debts due, the surplus of depreciation over new capital purchases—these all serve to release means of purchase and to turn the tide. The misleading effects of the accounting system are most manifest during the phases which form the crest of the cyclical wave.

A subsidiary factor in the process is speculation, which attempts to derive profits from the mere changes in prices. But obviously the speculator extracts his profits from the same rich source from which the manufacturer draws his. They both gain at the expense of the creditor who receives back the same amount of money plus interest, but a much smaller amount of purchasing power. It all comes back, however, to the essential miscalculation, which serves to drive a given price change beyond its original size.

In the formulation of his thesis Dr. Schmidt seems to conceive the Rechenfehler as a direct source of abnormal increase or decrease in the volume of means of purchase, as an inflation that accounts automatically for new changes in prices. But one can hardly agree to such a formulation. If there is a rise in prices, and as a result the entrepreneur finds himself with more money than he paid for the means of production, that increase in the means of purchase should be exactly proportional to the rise in prices already attained, and thus no increase in purchasing power should have really taken place. It is only in so far as the appear-

ance of these fictitious profits stimulates the entrepreneur to a greater use of bank credit, to an expansion that involves additional means of purchase from new sources, that the next rise in prices occurs.

But if such is the case, if the Rechenfehler does not in itself, mechanically, constitute an inflation responsible for a further rise in prices, can we conceive it with Dr. Schmidt as *the only* cause of business cycles? Can we assume that this discrepancy between estimates at old cost and present prices is the only factor that stimulates the business community to expansion? Is there not an increase in real profits due to the fact that some cost items, even at their repurchase value, increase less in price than the finished goods themselves? On the other hand, does not the business community tend to discount value increases that are due to price changes, obviously temporary?

The original element in Dr. Schmidt's thesis is the emphasis on the bookkeeping element. It thus points to a new source of inductive studies. The author himself analyzes changes in the balance sheets of four big German concerns. While revealing interesting results, the discussion shows also the difficulties connected with the analysis of this new material. The balance sheets are available only by years, as a rule. And one has to be intimately acquainted with the history of each enterprise, changes in policy, specific accounting methods, not to be misled or puzzled by some of the changes shown. There is no doubt, however, that the study of balance sheet and of other processes within each individual enterprise is a promising avenue of research. It has already been entered upon in this country, notably in the work of the Harvard School of Business.

Dr. Schmidt gives also a definition of industrial fluctuations, a brief description of the processes, and even a discussion of the various explanations. But in these sections he follows either Röpke, or Cassl, or Spiethof. The most interesting parts of the book are those dealing with the separate items of the balance sheets and with the exposition of the main thesis. Concerning both one feels that the discussion would have gained in value if the author had taken as less self-evident the connection between the Rechenfehler and business expansion. A more thorough analysis of the latter might have made the formulation less one sided and might have given more direct clues to the study of this particular element in the cyclical processes. But the thesis is interesting and significant enough to serve as a stimulus for the eager inductive workers in the field of business cycles.

SIMON KUZNETS

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Pollak Prize Essays, by R. W. Souter, Frederick Law Olmsted, C. F. Bickerdike and Victor Valentinovitch Novogilov. Newton, Massachusetts: Pollak Foundation for Economic Research. 1927. 131 pp.

The Road to Plenty, by William T. Foster and Waddill Catchings. Boston: Houghton Mifflin Company. 1928. 231 pp.

Pollak Prize Essays contains the results of the unique prize contest for the best adverse criticism of Foster and Catchings' book: *Profits*. The four essays printed include all those ranked among the first three by any of the judges.

Mr. Souter begins by attacking the thesis that industrial stagnations are a disease peculiar to a money economy. He does this by means of abstract cases showing how improvements would tend to the same result in a barter economy on account of mistakes, uncertainties and losses in the resulting readjustment of exchange ratios, and reapportionment of productive efforts. He then carries the same principle through the money economy, indicating that the evils here found have a similar source and that the taking of profits, by itself, need not create a drag on production. Like some of the other writers, he makes the point that Foster and Catchings shift the meaning of "profits" from the economists' net profits above wages of management and interest on investment, to total net earnings. But it can hardly be said that the essays dispose finally of the question whether this inconsistency is fatal to the argument. Mr. Souter expresses his contention in a statement liable to some misconstruction, saying: "The real problem is how to make the output of goods conform to the prospective flow of money." He means, of course, that the *direction* of productive activity must be governed by "consumers' freedom of choice" (including the choice to consume or invest) and that this problem will remain even if buying power is supplemented.

Mr. Olmsted deals with the processes by which potential productive power becomes actual, noting that increased productive power involves shifts in the kinds of goods produced, and in the balance between work and leisure; and that the outcome, as well as the difficulty of adjustment, is affected by the distribution of income between different classes. He is thus led to emphasize, and probably to overemphasize, the psychological forces in the problem, as follows: "Amidst the innumerable causes . . . the place to look for the most important improvements is apparently not in any mathematically demonstrable, inherent defect in the present economic mechanism, but in mental or psychological defects of the people who are operating the mechanism." He also notes that, in Foster and Catchings' hypothetical cases, the conclusion is assumed in the premises so completely as to make the detailed elaboration of the cases quite unnecessary.

Mr. Bickerdike elaborates the contention which he had made in a previous article, that a case can be worked out in which continuous saving and increase of production can be reconciled with a balanced condition of expenditure and output. This Foster and Catchings have themselves admitted, but as Mr. Bickerdike justly points out: "The most serious objection which must be taken to the book as a whole is precisely this: that the authors suggest everywhere some inherent arithmetical difficulty in reconciling saving with the maintenance of a sufficiency of consumers' purchasing power, but they do not work out in detail examples of cases in which the extension of money, the amount of saving, and a corresponding rate of growth go on simultaneously." For him: "The primary question to be determined . . . is not whether the sudden introduction of either increased production or of saving can be postulated without disturbance, but whether a smooth rate of growth, with corresponding saving, can exist." The distinction is well taken, but more significant than either would seem to be the question whether our system of assimilating growth is sturdy enough to absorb some inevitable irregularities without being thrown into depression by their diffused effects and intensified repercussions.

Professor Novogilov's essay is the only one of the four which attacks the accuracy of the Foster and Catchings cases on their own hypothetical ground. The basic error found is an understatement of profits due to substracting the expenses of producing eleven units of goods from the proceeds of the sale of ten units. As a result, the authors have made their corporation restrict production at a time when profits are actually increasing. Adjusting for this and other errors, Professor Novogilov finds that savings, within limits, tend to maintain rather than upset the balance of supply and demand as production expands. The trouble in the authors' cases arose, not from normal savings but from other savings which the authors themselves had apparently overlooked (in connection with the error already noted) and which had no relation to increased capital or production. It is this abnormal quality that makes the trouble; while the normal relation of savings to the production of capital goods of various orders is not adequately analyzed in *Profits*.

Not the least interesting part of this little volume consists of Foster and Catchings' own comments. They see nothing in the essays that is fatal to their main contention, and point to their own qualification, to the effect that cases could be constructed in which savings could go on and increased productive power find a market, if business would make the necessary adjustments, but that business does not make these adjustments. Does this qualification save their main contention or does it amount to an abandonment of it and a shifting to a fundamentally different ground? To the reviewer it appears to do the latter.

Indeed, if the reviewer may contribute his mite to the flow of criticism, the most serious weakness of the book would seem to consist in this ambiguity as between two different positions: (1) That there is an absolute, inevitable and progressive shortage in the distribution of purchasing power, unless made up from outside sources—presumably by an absolute and progressive subsidizing of buying power from sources not based on industrial production; (2) that the trouble is a lack of proper timing of adjustments in prices and the flow of incomes. Thus the critics have good reason if, with the first theory in mind, they conclude that it must lead to inflationist programs, which the authors disclaim.

The authors' ambiguous use of the term "profits" is really a part of this major ambiguity in their case. The first theory claims that net earnings (on *increases* in investment), produce an inevitable shortage of consumers' purchasing power. On this contention the first part of the book has no bearing, for it deals with economists' "pure" profits, which are balanced by losses, and may amount to nothing or less than nothing in the aggregate, as the authors point out. The uncertainties and fluctuations of this form of income do, however, have a bearing on the second form of the theory, but this bearing is effectively obscured by the authors' treatment.

The first theory is founded on the authors' series of hypothetical cases, and here the assumptions do involve the conclusion in a further way than that pointed out by Mr. Olmsted, and so directly as to make all elaboration superfluous: a mere clouding of the issue. It is assumed that in any period, goods sold are limited to goods produced in the preceding period. This assumes directly that the whole of any increase in production must remain unsold at the end of the period in which

it is made. Meanwhile, any increase in current disbursements can have no effect save to raise prices, after which the added output cannot be marketed at the new level of prices which has, by arbitrary assumption, been created. And as the authors assume that business cannot endure any fall in prices, even when production is being cheapened, an unmarketable output results. On the basis of *original* prices, the cases do not show a progressive shortage of buying power, but an alternate excess and shortage; the shortage leading to curtailed production because prices have been inflated and will not come down.

In the interest of realism, the first arbitrary assumption should be changed to allow a current increase in production to take effect in large part in increased current physical sales. This would reduce the first arbitrary increase in prices, reduce the corresponding need of a subsequent fall to dimensions which business, with the help of cheapened production, would be able to assimilate, and change the whole nature of the problem to one of proper timing of necessary adjustments rather than a progressive and unavoidable shortage of purchasing power.

If the question is mainly one of timing of adjustments, the alleged inadequacy of various "palliatives," such as instalment buying, must be reconsidered. If properly timed, this might take care of the entire difficulty, so far as it is grounded in alternate excess and shortage of consumers' purchasing power. Its real inadequacy seems to lie in the fact that there is no obvious way of so controlling it as to ensure the necessary timing of expansion and contraction—especially the latter.

To put the theory on sound ground it would seem necessary to scrap the original structure of hypothetical cases, start with the subsequent qualified form of statement, and develop its implications with due regard to the actual behavior of capital and product, including the principle of "diminishing productivity," which the authors ignore.

The above was, in substance, written before reading *The Road to Plenty*, in which the authors put forth at length their program. This book is cast in the mold of a Pullman-car conversation, and spends so many pages in the approach to the problem that inadequate space is left for issues ramifying out from the program itself. Nevertheless, the economics of this volume is superior to that of *Profits*, partly because it takes more account of the objections of orthodox economics, and partly because it makes clear that the part of the theory on which the authors propose to act is mainly the second, or imperfect-timing doctrine, not the more dangerous doctrine of progressive and inherent shortage of purchasing power. This cruder theory is constantly stressed, however, even though it ill fits the program which is ostensibly based on it. This is perhaps the chief criticism to be made of the book.

The program is, in brief, the timing of public works and of all public fiscal policies which may have an effect either on the demand for industrial products or on financial inflation and deflation, so as to reduce public expenditures when those of private industry are unduly expanded, and *vice versa*. This is to be guided by a more prompt and comprehensive system of barometrics than exists at present. The help of private agencies is also welcomed, as in budgeting the purchase of industrial equipment so as to build it up in dull times. A concession is made to the

absolute-income-shortage theory in reserving judgment as to whether the plan will ultimately require some permanent inflation or not.

There are two glaring omissions. The authors make no attempt to answer the obvious queries: "If instalment buying is a mere palliative because it cannot supply an *endlessly increasing* amount of credit, how can this plan do more?" and "Why will not this plan merely level out industrial activity at a point midway between the present peaks and depressions?" To answer this last satisfactorily, use must be made of some elements in the despised orthodox theory. It is clear, also, that the effects of particular fiscal policies need more detailed study: A matter on which the Pollak Foundation will no doubt publish further researches. In general, the program seems sound, and can stand without the less sound features of its supposed theoretical foundation.

The authors will presumably hold fast to this original theory, because it is apparently the road by which they reached their present conclusions, even though others might reach them by a more generally acceptable route. One is reminded of the history of Ricardo's labor theory of value. Ricardo ultimately included all the elements of a general cost-of-production theory, but admitted them as qualifications only, and handled them in such a way as to minimize their significance. The logical Marxian deductions he did not draw. And he later privately admitted that if he were to rewrite his theory, he would recast it from the beginning, so as to make these qualifications integral parts of the structure. The authors of *The Road to Plenty* have apparently gone some distance on a similar road. Will they ever take the final step?

J. M. Clark

The Industry and Trade of Japan, by S. Uyehara. London: P. S. King and Son, Ltd. 1926. 321 pp.

The purpose of this book is, according to the author, to present "an authoritative account" of the development of the industry and the trade of Japan during the past half century, "which is not otherwise readily obtainable." The need for such a work is obviously great. There are a large number of books on Japan, but to the serious student seeking intelligent and sympathetic treatment of the industrialization of Japan they are entirely inadequate. It cannot be said that the present author fully realizes his ambition and satisfactorily fills the need that exists, but it may be said that his *Industry and Trade of Japan* is the best book of its kind that is available in English at the present time. His section on Representative Industries is his best.

The great fault of the book lies in the treatment of the material at hand. The author has collected and assembled a great mass of undigested statistical material, which as it stands, is little more useful to the reader than in its original state in the three or four yearly statistical reports published in English by the various departments of the Japanese Government, where most of it can be found. If he had given a more analytical treatment to his material, eliminated the bulk of the tables and replaced them by charts, he would have made his study vastly more useful and readable and would, I venture to suggest, have been spared one or two

errors of judgment of which he is guilty. He has been unfortunately careless in the presentation of his statistical material thus lessening its value and at times unnecessarily obscuring the meaning. He has persisted in the very elementary error of confusing percentages with index numbers in tables, so that increases are sometimes overstated by 100 per cent. With some major errors in the first part of his book, the author undermines your faith in his work and it is difficult to keep on to Part V where his real contribution begins. It is a pity that he did not omit the first four parts and begin the book with Part V on Representative Industries.

The arrangement of the book follows the usual course. Beginning with an introduction which gives a brief survey of Japanese history and the development of trade and industry following renewed intercourse with the world, it passes to Part II which is an analysis of capital investment as an index of the extent and nature of the industrial development in the past half century. Part III is devoted to labor conditions and the background of agriculture. It is in this section that the author shows himself to be out of touch with conditions of agriculture. To anyone who has recently been in Japan, his statement that land is becoming more evenly divided among those engaged in agriculture is startling; and his conclusion that agricultural labor is tending to get a more direct interest in the land as tenant farmers is more startling. As a matter of fact the reverse is more nearly true. The independent farmer cultivating his own land has shown a decided tendency to decrease in number, while the number of tenant farmers and those farmers who are owner cultivators but who must also lease land has been on the increase. The tenant farmer class is therefore increasing at the expense of the independent small owner cultivator. The Government is encouraging tenant farmers to purchase land, by making loans at lower rates of interest than prevail in the market, but the amount of money appropriated is very small and the number of tenants becoming independent is insignificant. There is nothing to indicate that agricultural labor is as a whole bettering its position in relation to the land. Comparison of the author's table classifying the number of families engaged in agriculture with the official figures in the *Statistical Abstract* of the Department of Agriculture and Forestry of Japan shows that he has been led into this error through faulty translation.

Conclusions with respect to the number of people in agriculture are also in error. There are no figures available for this item and the author has arrived at an estimate by multiplying the number of families engaged in agriculture, by the average number of persons per family in Japan, an obviously unsatisfactory estimate, because the number of households especially in a country like Japan, does not increase at anything like the same rate as the population. The average number of persons per family is also probably greater in the rural communities than the average for the whole country. From this estimate applied over thirteen years, the author finds the agricultural population decreasing both relatively and absolutely and states that "Japanese agriculture is faced with the serious problem of how to retain a sufficient number of workers to maintain production at the present level." Japan has never been faced with the serious problem of how to keep a sufficient population in agriculture. The situation has been rather the reverse. Sons and daughters have been sent into factories because agriculture

could no longer support them. The cry of the industrialist has been against the large labor turnover due to the inevitable return to the farm. Japan is now, after half a century, building up a permanent labor supply for her industries. But she has not robbed her agriculture to do it, although factory labor is largely rural. Agriculture can no longer support the increasing population. Agricultural wages have gone up with the general rise in wages, such as it is, but that does not signify a shortage of people in agriculture.

Part IV deals with foreign trade and the change of Japan's position in world trade from an importer of finished goods to an importer of raw materials following the natural sequence of nations passing through the industrial revolution. Part V treats of the most important industries that have been developed, namely, silk, cotton and the other textiles, mining, engineering, railways, shipping, electricity and sugar. Part VI sums up the strength and weaknesses of Japan's position as an industrial nation.

The thesis of the book is that Japan has developed her industries by imitating western methods and adopting western machinery; that she has reached her present state of development largely through the impetus of two victorious wars of her own and the unprecedented opportunity offered by the Great War; that her present and future development are limited by a great lack of important raw materials, low efficiency and lack of technical skill. The author then launches into the worn out theory that Japan's great asset is her abundant cheap labor. He says, "Low wages and long working hours compensate to a certain extent for the high cost of raw material and other costs of production," and that "Long hours and low wages are essential for the Japanese industry." He lays the decline of each industry to the rise in wages. He shows how the cotton industry has been placed at a disadvantage by the rise of wages, he shows the same for shipping and for petroleum and for copper. Then he has a complete change of heart and states that, "It must be taken into account that higher wages do not necessarily result in higher costs of production, because an increase of wages means not only more highly skilled labor, special knowledge and experience, but an increase in quality and quantity of production." Not content to leave it thus he returns to his original theme a few pages later, to wit that, "What has contributed to progress all through the last half century is, above all, the fact that Japan has possessed abundant cheap labor."

After showing in many ways that Japan's future industrially must lie in the making of better grades of goods, of more and more refined products, he comes to the final conclusion that:

> It is perfectly clear that a country poorly endowed with those important resources will never be able to attain equal success in international competition with the more favored countries, except in industries which can be undertaken without skill and experience, should cheap labor be easily obtainable, as it covers to a certain extent the cost of imported raw material.

He has an opportunity to bring home an important truth which the Japanese industrialists in general do not seem to appreciate, that is, that their future lies in producing quality not quantity, but he fails at the very point of grasping that truth. He therefore leaves you with the feeling that he has learned most of the

fundamental economic principles of his subject but that he has been unable to coördinate his knowledge and make it function. The book, throughout, is a mixture of surprisingly frank statement of facts generally unpleasant to Japanese, of admissions of fundamental weaknesses in the national economy and of failure to sense the practical significance of these facts.

DOROTHY J. ORCHARD

Ratio Analysis of Financial Statements, by Alexander Wall and R. W. Duning. New York and London: Harper and Brothers. 1928. 349 pp.

When one of the ablest of practising credit men undertakes to make public his methods of analyzing business statements, the result is sure to be a valuable contribution to the study of credit risks. Mr. Wall, in closing his preface says, "The processes discussed seem to be an advance in analytical technique, but the perfect analysis is still somewhat remote." To this reviewer they would seem to be an advance of great importance even if their sole function were to focus the attention of the analyst on relevant phases of the financial statement which are usually overlooked.

Calling the credit risk as a whole 100 per cent, the authors grant an importance of 20 per cent to the cyclical factor, and an importance of 40 per cent to the personal factor, which they define as "honesty of intent and purpose coupled with ability of performance." They proceed to devote their book to a consideration of the remaining 40 per cent, the strictly financial factor; and, in the summary, suggest how it may illuminate the other two.

The first step in the method is the compiling of all available statements of like firms into a common statement. This statement is then reduced to a 100 per cent statement, by dividing each item in the asset side and the liability side by the total of items on each side respectively. The statement to be analyzed is then similarly treated for purposes of comparison. This much of the method has long been commonly used by banks.

The peculiar contribution of the authors, the percentage ratios indicated by the title, are as follows: Current ratio, worth to fixed assets, worth to debt, sales to receivables, sales to merchandise, sales to fixed assets, and sales to worth. These ratios are compiled first from the collective statement to be used as a yardstick, then from the individual statement under analysis. A different weight is given to each ratio according to the authors' estimate of its importance; and the whole may be reduced to one index number for each statement. The final index is obtained by dividing each individual statement ratio by the corresponding ratio of the collective statement on a percentage basis, multiplying the resulting figure by its weight, and totalling.

The danger appears to be in the possibility of overstressing the significance of this final index number and of the relationship of the ratios as compared with those of the collective standard. These figures can be of great value so long as they do not blind the analyst to the story that every business statement has to tell, especially when it is compared with previous chapters in the history of the same business. But if the busy executive is to use these ratios alone as a shor

cut to his credit decisions, he may overlook many important factors such as growth and increases in invested capital.

The obvious advantage of eight ratios as compared with the usual one—the current ratio—is that whereas the latter is subject to facile "window-dressing," it is virtually impossible for a company to dress all eight.

The appendix contains complete applications of the method to a variety of actual statements, with excellent criticisms. The style of the book is lucid and workmanlike, and nowhere have the authors lost sight of the limitations of their system, which is of unquestionable value to any bank credit department.

JOHN G. ROLPH

The Amalgamated Bank of New York

Workers' Health and Safety: A Statistical Program, by Robert Morse Woodbury. New York: The MacMillan Company. 1927. xi, 205 pp.

This book is the first, and we hope not the last, attempt to condense recent discussions of the morbidity and casualty statistics of gainful employment. Dr. Woodbury deals chiefly with the various projects which have been proposed during the past ten or fifteen years for collecting the health and accident statistics of industry. There is no apparent omission of any of the important items in the literature of the subject since 1913. The text has no equal as a catalog of the various uncoördinated attempts to collect statistics in this field of interest.

The book does not, however, meet the expectations or claims set forth in Dr. Moulton's introduction to the volume. The book does not contain, and no book of 200 pages could contain, "an *adequate* appraisal of the existing statistics on workers' health and safety." It is open to question whether a feasible program of statistics in this particular field could, at the present time, contain two types of recommendations: "first, the abandonment of superfluous compilations and the introduction of such changes in tabulation as can be made without any major reorganization of existing methods and procedure; and, second, recommendations for guiding the further development of statistics to meet present or future requirements." The existing compilations are not abundant, the methods and facilities vary sharply with the means and personnel available for the work, and the program of "requirements" is far in advance of anything which will be attainable within the life-time of statisticians and economists now living. Whatever deficiencies there are in the methods and substance of industrial health and accident statistics at the present time, may be charged back to the attempt some fifteen years ago to establish an all-too-inclusive wishful, academic program. What was needed then, and what is needed now, is a statement of the most rudimentary statistical program which *can* be funded and administered by industry and by the state labor departments or compensation commissions. This book does not meet that need.

Dr. Woodbury has stated the case of the academic school of industrial accident and health statistics. It is safe to prophesy that little if any progress will be made in the field of industrial accident and health statistics during the next

decade, if the program is not restated by persons in industry and in the state compiling offices, who know what it means to get funds, personnel and consistent performance for an accident reporting plan of even the most elementary character. The experience of the state departments of health, over the past fifty years, in securing reports of the so-called notifiable diseases, and the experience of the state motor vehicle bureaus in securing reports of motor vehicle accidents, strongly suggest the drafting of a program by persons who know what information on industrial health and safety *can* be obtained and tabulated. The public accident statistics program of the National Safety Council passed through the academic stage some six or seven years ago. This program met with no enthusiastic response, at that time, from police and motor vehicle officials. But when the system was revised by persons in direct contact with the patrolman or motor-car operator, and by persons who had to secure funds and personnel for tabulation and publication purposes, the adoption of the National Safety Council plan by states and cities proceeded apace. Today the system covers a population of 27,333,000 in our states and cities.

The Downey program for industrial accident statistics has not failed because of any organic deficiency in the program itself, but primarily because means and facilities have not been, and perhaps never will be, available to meet the full requirements of the plan. It is hoped that current consideration now being given to the system outlined in Bulletin 276 of the United States Bureau of Labor Statistics,[1] will result in the simplest sort of uniform, primary reporting procedure and in a tabulation program meeting only the rockbottom requirements of the case. Contact with personnel, compensation and safety directors in industry, a recital of the budgetary and technical obstacles encountered by state officials, and an inventory of the indispensable elements of an accident reporting system, would show that such a system must be keyed at the level of the paymaster's or time-keeper's clerk who prepares the primary report schedule or at the level of the legislator who appropriates state funds. The tabulation program will have to be simplified to fall well within the financial and technical resources of the average state labor or compensation office.

All that need be said about a system of official vital statistics for the United States was placed on record two hundred years ago by the courts of the Massachusetts Bay and Plymouth Colonies. Yet it was not until 1902 that Congress provided the means for the systematic collection of mortality statistics on a nation-wide basis through a division of the permanent bureau of the Census. We should have no vital statistics today if birth and death registration failed to take into account the exigencies of medical and obstetrical practice and the attitudes of legislatures toward registration and the state bureaus of vital statistics. Even at this late date, it takes the constant vigilance of our federal and state officials to maintain the registration of the elemental facts of birth and death within our states. And this in face of the fact that almost the first thing a state legislature *should* do under a newly-made constitution is to set up machinery

[1] *Standardization of Industrial Accident Statistics.* Reports of the Committee on Statistics and Compensation Insurance Cost of the International Association of Industrial Accident Boards and Commissions. Washington, 1920.

for establishing evidences of right! May we expect, therefore, that any marked progress will be made in a statistical field such as industrial health and safety which has few if any warrants of enforceable law?

Industrial health statistics have also gone through the stage of over-elaboration, over-emphasis and over-expectation. The reports of the Walsh Commission on Industrial Relations, the subsequent publications of the United States Public Health Service, the reports of committees representing the American Public Health Association and other organizations, all contain statements of desirable elements in a program of industrial morbidity statistics. The problem for official statisticians in this field at the present time is to convince managers in industry that they should maintain the simplest records of absenteeism due to sickness and to secure from them either the original records or proper tabular abstracts of the data. The contemporary supply of published material on industrial health exists because official statisticians have been tactful enough to secure the few records available and skillful enough to make the best possible use of the material on hand. There is not any likelihood for securing more or better statistics of health in industry until questions of need, cost and personnel for health-record purposes are settled.

Human nature being what it is, we may not be too sanguine about our capacity to secure data on the score of problems encountered in the prevention of accidents and sickness, in alleviating the consequences of these misfortunes and in distributing money costs through insurance or otherwise. There is always a huge gap between a statement of abstract principles and the expression of those principles in concrete form. This trite observation applies particularly to industrial health and accident statistics.

E. W. Kopf

Metropolitan Life Insurance Company

A Signpost to Social Insurance, by Evelyn Martelli. London: P. S. King and Son. 1927. 87 pp.

Limited to British social insurance this little volume has the merits of stating the fundamental provisions clearly and concisely, and it is up to date. The viewpoint is that of the feminist inquiring how does all this affect "women and their children."

Finding in operation national health insurance; unemployment insurance; non-contributory old age pensions; widows', orphans' and old age contributory pensions; and workmen's compensation, the author inquires for the National Union of Societies for Equal Citizenship in Great Britain, what is the position of women in this whole scheme.

First of all, "Many of these provisions invite criticism on their own demerits" —the maternity benefits, for example, are still inadequate, while other provisions for sickness and disablement and involuntary unemployment are inconsistent as between men and women. "Differentiation rests on an arbitrary rather than a real distinction," and the remedy for the "high sickness rate of married women

will be found not by allowing their insurance to be paid for by the contributions of men, which may be the case at present, but rather by removing the causes of the sickness." Naturally troubled by the present welter of unrelated British branches of social insurance the author proposes one unified scheme which she thinks "would enable the variations in liability to cancel each other out." Otherwise, she favors raising the contributions of the women, which at present are lower, so that there may be no distinction between men and women.

Dropping the flat rate and substituting a scale based on wages is not perfect since women on an average still earn less than men. This amendment, therefore, would fail to equalize the position of the two sexes. But wages of all women are not lower than those of all men. Contributions and benefits under social insurance might perhaps best be graded according to wages, although this involves greater administrative difficulties. Nineteen out of twenty-four governments reporting to the International Labor Office at Geneva have such graded systems for sickness insurance. The flat rate system of Great Britain is almost unique, and if insurance benefits are to represent the same value to all who receive them they must recognize varying standards of living and be graded according to wages. This would "facilitate the equalization of the position of men and women."

In a critical examination of the British system as a whole it is found that health insurance is inadequate both as to amount and scope while administration through approved societies is wasteful and not closely enough linked up with public health authorities. Unemployment insurance coverage is still incomplete, notably excluding agricultural laborers and domestic servants. The non-contributory old age pension scheme, for those over seventy, suffers because of the property qualification. The widows', orphans' and old age contributory pension plan—the youngest of the national schemes, in effect only since the beginning of the year 1928—is described as "a form of race insurance" which marks advance in protecting the worker and his family, not against various risks, but against the general danger of losing their income. Here no new administrative machinery was needed, since the contribution arrangements could be combined with those already existing for health insurance. The British workmen's compensation system is justly scored for inadequate benefits, failure to avoid litigation, failure to make insurance compulsory, and continuing the administration through the courts.

Finally, the author joins the growing list of English writers who in recent years have insisted that there must be a unification of all social insurance with economical administration, bringing the state into "direct contact with the insured population as an agency for securing the good life." It is significant that one finds no suggestion whatever that any part of the whole scheme of social insurance be abolished. Practical experience merely recommends its extension. "If," concludes the author, "the sovereignty of a modern state depends on its record of value given, there can be few stronger claims on the loyalty of its members than that of having removed from them the fear of destitution."

JOHN B. ANDREWS

American Association for Labor Legislation

The International Accounts, by Cleona Lewis with the aid of the Council and Staff of the Institute of Economics. New York: The Macmillan Company. 1927. 165 pp.

This book states the methods now or formerly used in presenting the figures of international mercantile, service, and financial operations; criticizes these methods; pleads for a standard form of reporting; and presents a hypothetical sample report embodying the suggestions made in the book.

It is only of late years that any attempt has been made, by any country, periodically to publish a comprehensive statement of the various items entering into the total of international economic transactions. The spasmodic estimates of these transactions made for varying purposes, at one time or another, by individuals or private organizations, are reviewed by the writer, and their defects, from the point of view of the inquirer into the debit or credit position of any particular country, clearly set forth. The recent annual publication of such figures by official bodies such as the United States Department of Commerce, the British Board of Trade, and the League of Nations is commended, though the form adopted is condemned. The author takes the view that all the purposes which these figures serve will best be met by the adoption of an accounting form comparable to that used in private business. The international accounts should separately present (1) an *income* account for the period under consideration, (2) a statement of current *capital* transactions, (3) a comparative balance sheet showing the international debt and investment position of the country concerned at the beginning and end of the period covered by (1) and (2). The investigation necessary to secure the data for these accounts should be supplemented by a periodic census (once every five or ten years) of the foreign debts and investments of the country in question. Such a census is of course necessary before statement (3) in the series of accounts could ever be made, and later censuses would serve as a check upon the accuracy of the annual estimates.

There is little to be said to this except to assent. A uniform type of accounting would be of great service in presenting international as well as other transactions and the form proposed by the author would seem to meet most requirements. One can only hope that it will be universally adopted. It may perhaps be suggested that the practise of showing the full amount of such counterbalancing items as exports and imports of merchandise, in determining the net figure, might well be carried over into the service items such as commissions, insurance, freight, etc. This is not done in the sample income account. (Page 94.)

In the use of the international accounts a caution should be entered against regarding them as the financial statement of a private business, the form of which they copy. The international accounts include both producers' and consumers' operations. That of a business corporation includes only producers' operations. Since consumers consume what producers produce, a country which is perfectly solvent, neither lending nor borrowing, will show no net income in the international accounts. A borrowing country would, in the terminology suggested by the author, show a net outgo on income account. In either case, such a country might be a perfectly good credit risk, though, from similar data in the case of a private business corporation, no such inference could ordinarily be drawn. The

two types of statement are not, though the author seems to assume they are, in this respect comparable.

The book provides a very useful compendium of studies of international transactions covering many countries and a long period of time.

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